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SCIENCE & TECHNOLOGY

USSR: ENGINEERING & EQUIPMENT

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UDC 532.768.089.6:620.168.336.05

MASTER CENTRIFUGE PTS3M FOR INSPECTION AND CALIBRATION OF ACCELEROMETERS

18610213c Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 87 pp 34-35

[Article by V.A. Dyachenko, M.N. Polishchuk, and A.N. Timofeyev]

[Abstract] Inspection and calibration of accelerometers with a main error of 0.3-1.0 percent require a master centrifuge with continuous or only slightly discrete rotor speed regulation which reproduces accelerations with an error not larger than 0.1 percent and determination of its rotor speed with an error not larger than 0.01 percent. This requirement is met by the PTs3 centrifuge, namely the updated PTs3M version. The centrifuge consists of a circular platform on a vertical shaft carrying base plates slotted on top for radial keys and peripheral angle brackets which hold containers with accelerometers. Its electric drive is a d.c. motor with automatic pulse-phase-modulation control and a reliable compact 22-channel mercury slip ring on a vertical shaft coupled to the platform shaft through a bellows, also an instrument transducer of rotor speed consisting of a rotor mounted on the same shaft as the slip ring inside a stator with two identical rings of 200 teeth on the bore side. Design and performance of the centrifuge and the transducer are based on a system of four second-order ordinary differential equations of motion for a 3-mass vibratory system and two inequalities defining the conditions for stability. The rotor speed is set by a wideband variable-frequency oscillator with quartz stabilization. Automatic rotor pull-in, speed stabilization, and dynamic braking are ensured by astatic pulse-phase modulation. Figures: 2; references: 3 all Russian.

02415/9365

UDC 621.438-253:534.1

DEPENDENCE OF VIBRATION ACTIVITY IN AXIAL AND RADIAL TURBINES ON RATIO OF NUMBER OF RUNNER BLADES TO NUMBER OF NOZZLE BLADES

18610219a Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 31 Mar 87) pp 14-18

[Article by B.I. Borovskiy, A.I. Chucherov, and V.L. Khitrik]

[Abstract] Considering that the intensity of vibrations in rotodynamic machines depends on the ratio of the number of moving runner blades to the number of stationary nozzle blades, this dependence is analyzed theoretically in appropriate systems of coordinates for values of that ratio at which aerodynamic forces will not be transmitted to the runner and to the nozzles. Vibrations excited by a gas-dynamic lift force nonsteady but periodic in time, dependent on the distribution of nozzle exit velocity, are considered under conditions of nonseparation flow through the convergent nozzle channels. The frequency spectrum of this force is established by expansion of the latter into an approximating Fourier series and its resolution into principal space components. The procedure yields values of that ratio to be avoided so as to avoid excitation of the various vibration modes, whereupon those vibrations will be altogether suppressed or at least minimized. The results apply to axial and radial turbines also to pumps and compressors. Figures: 2; references: 4 Russian.

2415/9365

UDC 629.735.33.015.3.025.58

COMPARISON OF ANNULAR AND ELLIPTICAL WINGS WITH REGARD TO AERODYNAMIC CHARACTERISTICS

18610219b Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 11 May 87)
pp 29-31

[Article by M.D. Zhuravlev and S.A. Matveyenko]

[Abstract] An experimental study of three different annular and three different elliptical as well as six composite aircraft wings, with and without sweepback, was made for a comparison of their aerodynamic characteristics. The results indicate that increasing the sweepback lowers the frontal drag but also lowers the load capacity. Some load capacity of elliptical wings could be recovered by adjustment of the ratio of semiaxes. Wings with reverse sweepback have characteristics close to, and at large angles of attack better than, those of wings without sweepback. The "warp" configuration with a closed wing, unlike a conventional wing, is not subject to "pitching" during passage through the vortex trail behind fins. Figures: 4; references: 5 Western.

2415/9365

UDC 629.735.45:621.43-44:532.525

CALCULATION OF DROPLET TRAJECTORY IN COMBUSTION CHAMBER OF UNIFLOW AIR-JET HELICOPTER ENGINE

18610219c Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 30 Mar 87)
pp 32-35

[Article by Yu.N. Zotov and A.P. Merkulov]

[Abstract] Motion of a droplet in the combustion chamber of a uniflow air-jet helicopter engine is analyzed, assuming steady circular flow of the gas mixture in the chamber. The mixture components are assumed to be ideal gases, their thermophysical properties and the isentropic exponent varying in time. The pressure gradient, Archimedes force, reaction force, and fractionation of the fuel while it vaporizes are ignored so that motion of a droplet is determined solely by interaction of the liquid phase and the gaseous phase. This motion and attendant flow of the gas are described by three first-order differential equations, one for each space component in a Cartesian system of coordinates, with the drag coefficient equal to $13/N_R^{0.5}$ over the relevant 10-1,000 range of the Reynolds number N_R and with the kinematic viscosity of the gas taken at the "one-third rule" temperature. These equations are supplemented with the two equations of evaporation and heat balance. Numerical solution by the Runge-Kutta method has yielded droplet trajectories under various specific conditions. Figures: 4; references: 6 Russian.

2415/9365

UDC 539.3

AXISYMMETRIC STRAINS IN AIRCRAFT TRANSPARENCIES WITH CONSIDERATION OF COMPLIANCE OF THE MOUNTINGS

18610291d Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 1 Oct 86)
pp 43-48

[Article by V.N. Paymushin, V.A. Firsov, and Kh.B. Mamedov]

[Abstract] Relations for parametric analysis of static axisymmetric strains in aircraft transparencies such as fairings, windows, and canopies are derived on the basis of a mathematical model describing a shell of revolution constrained along both surfaces by discrete thin deformable cleats. The frames of these components and all force-transmitting elements are assumed to be perfectly rigid as compared with the shell so as to be virtually immovable. The axisymmetric problem of contactive interaction is formulated for small displacements and strains. The corresponding three equations of balance for the shell and one for each cleat are supplemented with static boundary conditions at the edges and kinematic conditions of shell-cleat coupling. This complete boundary-value problem is reduced to algorithms readily programmable in FORTRAN-4 language for numerical solution on a YeS computer, which reveals the dependence of strains on the elasticity-compliance characteristics of constraining cleats. Figures: 4; references: 2 Russian.

2415/9365

UDC 629.735.33

DESIGN OF MODELS IN LOGIC FORMALISM FOR AIRCRAFT ASSEMBLY

18610219e Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 13 Jan 87) pp 70-72

[Article by R.I. Guseva and Ye.N. Ryzhov]

[Abstract] Design of models for aircraft assembly on the basis of set theory and logic formalism is considered, a theorem about forbidden combinations of assembly bases being proved with each combination treated as some nonempty set. Application of this theorem to assembly of wing caisson consisting of panels, spurs, and ribs demonstrates that it automatically facilitates selection of an allowed combination without prior analysis. References: 2 (1 Russian, 1 Western (in Russian translation)).

2415/9365

UDC 539.3

WING DESIGN TAKING INTO ACCOUNT ELASTICITY OF FUSELAGE

18610219f Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 3 Nov 86) pp 82-85

[Article by V.V. Kuzmin and F.I. Figurovskiy]

[Abstract] Design of a wing is outlined which takes into account elasticity of the fuselage in load calculations by the method of finite elements. The design procedure allows for nonuniform spacing of hoops and for differences in their stiffness, also freedom in selecting the number of hoops along the lateral chord. The distributions of normal displacements and stresses over both leading and trailing edges of a wing from its root at the fuselage to its tip indicate larger displacements and slightly smaller stresses than when calculated without elasticity of the fuselage taken into account. Figures: 2.

2415/9365

UDC 533.6.011.3:629.7.036

EXPANSION OF LIQUID JET TRANSVERSELY INJECTED INTO GAS STREAM IN MIXER

18610219g Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 6 Mar 87)
pp 90-92

[Article by M.Ye. Rudyak]

[Abstract] Expansion of a liquid fuel jet upon its transverse injection into an air stream was studied in an experiment, the jet width inside the chamber being an indicator of jet core breakup during the first stage of the mixing process. Measurements were made in square mixer channels of various sizes as well as in a circular one 21 mm in diameter. Jets were injected through holes 1.01, 1.50, and 2.01 mm in diameter (the depth of each hole was more than 3.5 times its diameter) in a transparent window made of acrylic glass in one channel wall. Temperature of the air and static pressure prior to jet injection were 280 K and 1.2 MPa, respectively. The jets were bending in the direction of the air stream upon entrainment by the latter, the bending radius being determined by the ratio of the two respective velocity heads. As the air velocity was varied over the 50-90 m/s range with the Reynolds number larger than 10^5 and the jet discharge velocity was varied over the 7-30 m/s range, that ratio of air velocity head to jet velocity head varied from 0.1 to 1.2 with either kerosene TS-1 or Freon-318 used as jet forming liquid. High-speed spark photography of jets at 8-10 points along the trajectory has yielded data which indicate that a sharply-bending jet expands in stages forming an intricate ladder pattern with variable velocity, the ratio of jet width to distance from the orifice to the plane of confluence found to depend on the jet core flattening and on the ratio of the two velocity heads.
Figures: 3; references: 7 (5 Russian, 2 Western).

2415/9365

UDC 533.6.011

CHARACTERISTICS OF FLOW PAST HEMISPHERE STANDING ON PLANE BASE

18610219h Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 87 (manuscript received 24 Feb 87) pp 99-101

[Article by N.A. Shushin]

[Abstract] Flow of air past a hemisphere standing on a plane base was studied experimentally inside a flat continuous-duty wind tunnel with stagnation at atmospheric levels. The hemisphere with a 38 mm base diameter was made of methyl methacrylate with drain holes drilled and thermocouple junctions mounted in the plane of a meridian. Drain holes were also drilled in the tunnel walls. Supersonic and subsonic air streams with the Mach number 2.02 and 0.8, respectively, were generated by appropriate nozzles, covering the entire width of the hemisphere at the base. The boundary layer before the hemisphere was 3.8-5.7 mm thick. Pressure fluctuations were measured with a piezoelectric transducer and recorded on an oscillograph. The results indicate that the flow pattern is a combination of that for flow past a cylinder and past a sphere, also those before and behind a step. Figures: 2; references: 3 Russian.

2415/9365

UDC 681.78.083.8:531.71

TWO-CHANNEL OPTICAL TRANSDUCER FOR TECHNICAL VISION SYSTEM

18610213a Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 87 pp 17-18

[Article by A.A. Bolshanin, S.M. Slobodyan, A.R. Yakovlev, and L.A. Vasilyeva]

[Abstract] An optical transducer for a technical vision system which monitors and measures shaft diameters during quality control on the basis of a given tolerance field is described. This transducer consists of two identical and simultaneously operating photoreceiver channels with charge-coupled devices controlled by a common multifunctional signal generator. Two types of charge-coupled devices are used here in linear arrays, 1024-element K1200TsL1 series devices and 2048-element K1200TsL2 series devices, the advantages of linear arrays over grid arrays being higher space resolution and higher spectral sensitivity with a more uniform distribution of the latter. Each transducer channel includes an objective which projects the image of a shaft segment onto the photoreceiver surface with a magnification determined by the ratio of shaft segment dimension to CCD chip dimension, a linear charge-coupled device which converts the light intensity distribution into an electric signal, video-signal processing circuitry, encoding circuitry, and a comparator-resolver. The comparator-resolver tests encoder readings for three possible categories of diameter sizes and correspondingly commands the manipulator servomechanism to reject a shaft with diameter smaller than minimum allowable, accept a shaft with diameter larger than minimum and smaller than maximum, or return a shaft with diameter larger than maximum allowable to the machine tool for further turning. The transducer is calibrated against a standard reference by regulating either the repetition rate of shadow-project scaling pulses or in the clock frequency of lead-out charge packets while reading an indicator panel of light-emitting diodes. The accuracy of such a technical vision system can be maximized by interpolation of the CCD output signal, until the dispersion of intrinsic CCD noise becomes the limiting factor. The measurement error caused by inefficient charge transfer can be compensated in real time by means of a recursive second-order filter. The transducer features a high degree of circuit integration on series K140, K155, and K531 chips, TTL circuits interfacing it with a microcomputer as well as with the manipulator servomechanism. Its dimensions are 60x90x100 mm^3. Figures: 2; references: 6 (4 Russian, 2 Western).

2415/9365

UDC 535/863:666.189.2

INCREASING RESOLVING POWER OF FIBER-OPTIC VIEWING SYSTEMS BY SCANNING INPUT IMAGE

18610217a Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 87 (manuscript received 27 Oct 86) pp 1-5

[Article by A.V. Yershov and P.A. Mikheyev]

[Abstract] The method of "slow" image scanning was applied experimentally to a fiber-optic viewing system, for an evaluation of its effectiveness. First was determined the contrast dependence of both static and dynamic resolving power, the effect of eye movement and attendant physiological factors being then separated out on the basis of analogous measurements with a conventional viewing system. The apparatus included an objective and an ocular, also a master collimator with a Foucault grating as viewed object in its focal plane. Several gratings with different contrast and resolutions were tested, a compensator formed by a pair of contiguous wedges scanning the object while rotating about its optical axis. An evaluation of the data and analysis of the fiber-optics stranding characteristics reveal that the relative increment of resolving power depends on the object contrast and on the background illumination, "slow" scanning being most effective when the contrast is low. Scanning speed and amplitude corresponding to optimum dynamic characteristics also yield the maximum increment of resolving power. The optimum number of scanning elements, of fiber strands or bundles, was found to be 20 or thereabout. Figures: 4; references: 23 Russian.

2415/9365

UDC 621.396.2.029.67

ERROR OF MEASUREMENT OF TIME POSITION OF LIGHT PULSES UPON THEIR PASSAGE THROUGH TURBULENT ATMOSPHERE

18610217b Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 87 (manuscript received 17 Dec 86) pp 5-6

[Article by Yu.V. Pleshanov, E.V. Pikkel, V.D. Samoylov, and M.S. Chukin]

[Abstract] Distance measurement by means of a pulse-laser range finder is analyzed for accuracy, the sought distance being proportional to the time interval between incident light pulses and thus to the difference between their time positions. A simple expression for the r.m.s. error of time position measurement is derived, after the pulse rise time has been averaged over all readings in accordance with probability distribution laws applicable to a Gaussian signal and log normal fluctuations of the threshold crossover time. Numerical estimates are made for a YAG:Nd laser emitting pulses of 15-20 ns duration and a Si photodiode acting as photodetector with pseudo-optimum filtration of electric signals. References: 7 Russian.

2415/9365

UDC 531.715

LASER INTERFEROMETER-DEFORMOGRAPH WITH MULTIPASS OPTICAL SYSTEM

18610217c Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 87 (manuscript received 5 Dec 86) pp 24-26

[Article by M.I. Ivanovskaya, V.S. Udaltsov, and V.D. Kostousov]

[Abstract] A laser interferometer-deformograph for geophysical research is described, its geometrical base being 12.5 m long and the Michelson interferometer having unequal arms with a multipass optical system in the measuring arm. Its design and performance are based on the dependence of the interferometer output signal amplitude on the input signal frequency, assuming a plane incident wave, the interferometer response being a strongly nonlinear but periodic function of that frequency. The length of the geometrical base determines the frequency range within which the nonlinearity remains negligible. Use of multipass optics maximizes the relative sensitivity of such an interferometer, without requiring a longer base. A prototype was built with a He-Ne laser, a beam-shaping telescope, a beam-splitting cube, and a system of mirrors which provides a 100 m long path difference. It was tested with a Gaussian laser beam and, with the aid of an acoustooptic modulator, found to record displacements as small as 2 percent of the width of an interference fringe within periods of time as short as 10 minutes. Its relative sensitivity, therefore, is not worse than 7.10^{-11}. Figures: 3; references: 7 Russian.

2415/9365

UDC 535.87

GENERAL-PURPOSE ABSOLUTE REFLECTOMETER

18610217d Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 87 (manuscript received 17 Dec 86) pp 28-30

[Article by V.M. Zimin, R.B. Tagirov, and R.V. Daminov]

[Abstract] An absolute reflectometer is described which can measure reflectance of not only plane mirrors but also convex and concave spherical ones. It consists of two channels, an alignment channel for positioning the tested mirror and a measurement channel for determining the intensity of incident radiation as well as that of reflected radiation at the mirror surface. The measurement channel includes an infrared globar lamp, an electromechanical modulator, an ellipsoidal mirror objective, a pyroelectric infrared radiation receiver with signal amplifier and electronic bandpass filter, also a digital voltmeter. The receiver can be rotated around the tested mirror and translated along the optical axis. The alignment channel includes a He-Ne laser, a target and a diaphragm with a hole sufficiently large but not larger than necessary for passage of the laser beam. Design and performance of this reflectometer are based on applicable relations of geometrical optics in the "think lens" approximation, both the objective mirror and a spherical tested mirror being replaced by an equivalent thin lens each and a plane tested mirror being treated as a spherical one with infinitely large radius. The alignment channel serves to adjust the tested mirror so that the axis of rotation of the radiation receiver becomes tangent to the mirror surface at the center of its tested segment. Figures: 1; references: 1 Russian.

2415/9365

REGULATIONS ON CREATION AND SUPPORT OF ACTIVITY OF TEMPORARY CREATIVE COLLECTIVES FOR INTRODUCTION OF PROMISING DEVELOPMENTS OF INNOVATORS INTO NATIONAL ECONOMY AT ORGANIZATIONS OF ALL-UNION SOCIETY OF INVENTORS AND INNOVATORS AND AT SCIENTIFIC AND TECHNICAL SOCIETIES

18610437b Moscow MASHINOSTROITEL in Russian No 4, Apr 88 pp 12-13

[Regulations]

[Text] The USSR State Committee for Science and Technology, USSR Gosplan, the State Committee for Labor and Social Problems, the USSR Ministry of Finance, and the AUCCTU confirmed the "Regulations on Creation and Support of the Activity of Temporary Creative Collectives on Introduction of Promising Developments of Innovators Into the National Economy at Organizations of the All-Union Society of Inventors and Innovators and at Scientific and Technical Societies." The editors publish it in this issue of the journal for broad familialization of the scientific and technical community with it.

1. Temporary creative collectives are created for more effective use of the labor resources and creative potential of workers, for accelerated introduction of promising developments, inventions and highly efficient innovator proposals into production, and for rendering intermediary services directed toward intensification of the national economy by solution (postulation) of the corresponding organizations in which they are created.

2. Councils (boards of administration) and organizations of the All-Union Society of Inventors and Innovators (VOIR) and of scientific and technical societies (NTO) conclude agreements on a cost-accounting basis to fulfill research, development and other intermediary services with State enterprises (associations), and other enterprises regardless of their departmental subordination, with cooperatives, and also with private individuals and create temporary creative collectives (VTK) for fulfillment of the work stipulated by these agreements.

3. Temporary creative collectives are formulated from skilled specialists, engineers, economists and scientific workers--members of VOIR and NTO on the recommendation of councils (boards of administration) and of the organizations of the named societies.

4. The temporary creactive collective implements its activity on the basis of contract agreements with the council (board of administration), and organizations of VOIR and NTO in which the subject of the entrusted work, the work plan, the deadlines for completion of it, special requirements, procedure for transfer and reception of completed work, mutual responsibility of the parties and other conditions are determined.

The organization (enterprise)--the client--supports the VTK with equipment, materials, complete sets of products, apparatus and other services required to complete the work, according to agreements concluded by the councils (boards of administration) of VOIR and NTO with the clients of the jobs.

The members of VTK fulfill developments during free time from their main job.

The participation of specialists, engineers, economists and scientific workers in the activity of temporary collectives is not considered holding more than one office.

5. Effective guidance of the activity of VTK is entrusted to its manager, selected at a general meeting by the members of the VTK and confirmed by the corresponding council (boards of administration) of VOIR and NTO.

The manager of the VTK organizes all the work and bears full responsibility for the activity of the VTK and for the results of its work. The activity of the VTK is monitored scientifically and systematically by the councils (boards of administration) of the VOIR or NTO in which they are created.

6. Members of the VTK are expelled from membership at a general meeting of the VTK by a majority of votes and is confirmed by the organization that created the given collective or by decision of the corresponding council of VOIR and NTO.

7. The general deadline for completion of developments by the VTK should usually not exceed 12 months.

8. The activity of the VTK is terminated upon completion of the effective period of the contract or upon qualitative completion of the work ahead of schedule and also upon obtaining a negative result or upon establishing the incapability of the members of the VTK to complete the tasks entrusted to them. A VTK is liquidated by the corresponding decree of the Presidium of the council (board of administration) by an order on organization of the VOIR and NTO.

9. The managers of the client enterprise bear responsibility for the timeliness and degree of working out the feasibility study, acceptance and production assimilation (practical use) of the results.

10. Expert committees can be created from highly skilled specialists to determine the volume and cost of jobs according to the orders arriving from the client enterprises, for acceptance of a completed job, for evaluating the quality and completeness of fulfillment of a job and also for determination of the prospects of development by the council (board of administration) and by the organization of the VOIR and NTO.

The expert committee:

evaluates the complexity of the postulated task and the volume of work;

determines the need for patent study;

evaluates the anticipated national economic saving due to use of the results of solving the scientific and technical problem;

after completion of the development, presents conclusions about its scientific and technical level, technical and economic results, about conformity to State Standards, specifications, models, conditions, deadlines and regulations.

11. The completed development is transferred to the client, who is obligated to review it within the deadlines stipulated by normative documents. Transfer of the results of scientific and technical or design work to the client enterprise is formulated by a bilateral acceptance-turnover report.

The VTK bears responsibility for fulfillment of the work within established deadlines and the reliability and quality of the results when completing scientific and technical and design work according to economic agreements with the client enterprises.

Payment for scientific and technical products, services and other jobs performed by the VTK in the interests of the client is made according to agreed prices. Prices for scientific research, planning, design and technological work, an experimental product, scientific and technical services and other types of work are coordinated with the client before the beginning of the job as a function of the required efficiency, quality and deadlines for completion of the work.

If the work is stopped through the fault of the client, it is paid for by him according to the actual labor, financial and material expenditures with the level of profitability envisioned in the price for the given work.

12. The work completed by organizations of VOIR and NTO by using a VTK is financed from the client's funds and also from bank credits. A reckoning is made after completion of the work within 2 weeks from the moment the acceptance-turnover report is signed.

13. The members of the VTK are paid for their labor from the client's funds, turned over to councils (boards of administration) of VOIR or NTO for the work completed according to economic contracts, with subtraction of expenses for raw material, materials, depreciation, for paying for the services of outside organizations, transport expenses and expenses for use of bank credits, deductions for state social insurance, of the appropriate tax within established procedure, and also deductions by the councils (boards of administration) of VOIR and NTO according to previosly established norms. The size of the wage of each member of the VTK is determined by the temporary creative collective according to the quantity and quality of labor and personal contribution to creation of income, and is taxable within established procedure.

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MASHINOSTROITEL REVIEW OF PREYS BOOK ON PROBLEM OF DEVELOPMENT OF ROTOR EQUIPMENT

18610437h Moscow MASHINOSTROITEL in Russian No 4, Apr 88 p 46

[Review by Candidate of Technical Sciences A. G. Ionov, winner of USSR State Prize, of the book of V. V. Preys "Tekhnologicheskiye rotornyye mashiny" [Production Rotary Machines], Moscos, Izdatelstvo "Mashinostroyeniye", 1986]

[Text] The timeliness of publication of V. V. Preys's book "Production Rotary Machines" is determined by the qualitatively new phase of the economic development of the country's national economy, related to solution of important problems under conditions of accelerated scientific and technical progress. The many years of labor of collectives of planning and design offices, scientific research institutes, and higher educational institutions, working in the field of development and operation of rotary and rotary conveyer machines, is generalized in it. These progressive machines have already found broad application in the most important sectors of the national economy.

The book consists of a preface, written by Academician L. N. Koshkin, an introduction, four chapters and conclusions. It is distinguished by clear architectonics, clear exposition of the material, accessibility to a wide range of specialists, and well thought-out methodological structure, which is clearly linked to the dialectical aspects of implementation of automation as the highest form of development of technology and of production technology. Special attention is devoted in the book to the use of rotary and rotary conveyer lines in machine building. The schematic and process flow diagrams and characteristic features of rotary machines and lines, used for assembly of aerosol valves, modules of bushings-roller circuits, heat treatment of welded electric drives, casting of thermosetting resins and other products are considered on specific examples.

The book permits specialists not only to become better acquainted with the prospects of developing rotary equipment, but of achieving qualitatively new results in consolidation of specialists of other scientific and technical directions by integration of different fields of knowledge.

The emerging role of Acting Member of the USSR Academy of Sciences, Hero of Socialist Labor L. N. Koshkin at all stages of generation and development of the idea of rotary technology, who emerged many years ago as a far-sighted scientist, supporter or rotary machines, fulfilling a unique honorary role of accelerator of scientific and technical progress in the given field of science and technology, is clearly followed in the book.

When reading the book, one notices the definite nonuniformity in the volume of material and the degree of detail of the outlined sections. For example, problems related to the use of rotary and rotary conveyor lines in machine building are outlined in more detail. The restricted volume of the book apparently did not permit the author to show the advantages of rotary technology, for example, in manufacture of ice cream products. It is known that Soviet specialists are highly regarded in development of rotary freezing units, which are used extensively in the meat, milk and fish industry and especially on factory ships.

Despite this, the book will undoubtedly attract the attention of a wide range of specialists toward solution of an important national economic problem and also young people, who must realistically implement the advances of leading experience and who must raise the production forces of the national economy to a level corresponding to the economic and social needs of Societ society.

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UDC 621.039.56

MATHEMATICAL MODELING OF DYNAMIC MODES OF ELECTROMAGNETIC DRIVE FOR CONTROL AND SAFETY RODS IN HIGH-TEMPERATURE GAS-COOLED NUCLEAR REACTORS

18610116b Moscow ENERGOMASHINOSTROYENIYE in Russian No 12, Dec 87 pp 27-30

[Article by V.V. Voskoboynikov, doctor of technical sciences; P.P. Usov, candidate of technical sciences; A.F. Lineva, engineer; S.N. Pushkin, engineer; and V.I. Tsukanov, engineer]

[Abstract] A mathematical model is constructed describing the dynamic performance of an electric stepper motor which derives control and safety rods in a high-temperature gas-cooled reactor, such a rod being filled with material which absorbs neutrons and embedded in a granular pile which resists its motion. A four-phase stepper motor is considered, running on nonmagnetic bearings with the rotor mounted on the shaft through a nonmagnetic sleeve-insert and with nonmagnetic spacer rings inserted in both rotor and stator cores. The differential equation of motion, which includes pertinent magnetic and electric circuit parameters, is solved numerically upon its conversion into a difference equation, nonlinear with respect to displacement, assuming no magnetic saturation in the motor structure. The model has been computer analyzed and validated experimentally by simulation of real surge loads. With appropriate modifications, it is applicable to rod drives in other types of reactors such as water-moderated water-cooled power reactors or research reactors. Figures: 6; references: 4 Russian.

2415/9365

ROLE OF PERESTROYKA IN RENEWAL OF SOCIALISM

18610437a Moscow MASHINOSTROITEL in Russian No 4, Apr 88 pp 1-2

[Article by Candidate of Historical Sciences V. N. Shvedov, Candidate of Historical Sciences M. I. Shvedov, and V. I. Gazetov: "Continuing the Revolution"]

[Text] The Soviet people celebrate the 118th anniversary of Vladimir Ilich Lenin's birth--the brilliant theoretician and leader of the world proletariat--in active preparation to the 19th All-Union Party Conference. The concept of developing our country, worked out by V. I. Lenin, along the path of building of socialism in light of the general prospects for a worldwide liberation movement is now the guiding principle for all communist parties in the struggle for building of socialism and communism. The CPSU constantly turns to the creative laboratory of V. I. Lenin, using his teachings to solve the strategic problems of improvement of developing socialism. "At the modern phase," noted M. S. Gorbachev at the June (1987) Plenum of the CPSU Central Committee, "the Soviet people and party, being guided by Lenin's teachings, and creatively developing them, continue the revolution through perestroyka and renewal of all spheres of life of society."

The concept and strategy of accelerating the socioeconomic development of the USSR and the course toward renewal of socialism, advanced by the April (1985) Plenum of the CPSU Central Committee, were developed theoretically and politically in the decisions of the 27th Party Congress, in subsequent plenums of the CPSU Central Committee, and were formulated in the general line of revolutionary perestroyka of Soviet society. Revolutionary perestroyka is the most important and most radical program for renewal of socialism during all our history after V. I. Lenin's death. "The purpose of perestroyka," noted M. S. Gorbachev, "is to completely renew Lenin's concept of socialism theoretically and in practice, in which indisputable priority is given to the working man with his ideals and interests, and is given to humanitarian values in economics, social and political attitudes and in culture."

The past year essentially completed the first phase of perestroyka. The Soviet people, in implementing the decisions of the party and

government, provided further growth of social production during the 70th anniversary of the Great October Socialist Revolution and provided an increase of production efficiency. For the first time in many years, the entire increase of production was due to an increase of labor productivity without an increase of the numbers of workers involved in material production sectors. National production income comprised approximately 600 billion rubles (in actual prices) in 1987. Industrial products increased by 3.8 percent compared to the previous year. Agricultural products were worth 220.1 billion rubles, which is 9.3 percent higher than the yearly average during the 11th Five-Year Plan.

There were positive changes in intensification of social production. More than 3,000 models of machines, equipment, apparatus, instruments and automation equipment and 322 computer-aided design systems were created last year. Progressive forms of integration of science and production were developed. Approximately 500 scientific production associations and 23 intersector scientific technical complexes, one of the main tasks of which is to reduce the periods of development and introduction of new equipment, are functioning in the national economy. A total of 43.5 billion rubles of State capital investments was used for technical retooling and renovation of existing enterprises, which is 7 percent more than in the previous year. Capital investments for these purposes were assimilated by 103 percent. Among the total volume, more than half consisted of the funds of enterprises and organizations. The output of progressive equipment was increased, including that of rotary and rotary conveyor lines of 1.5-fold for machine building and metal-working and 1.2-fold for computer hardware for scientific research. Production of more than 4,000 new types of products was organized and begun. The planned rate of renovation of industrial products was exceeded on the whole by the machine-building complex.

More than 16 million tons of fuel and energy resources (in conditional terms), 2.1 million tons of rolled ferrous metals and 8 million cubic meters of lumber and 145 million gigacalories of secondary fuel resources were conserved in the national economy. The established tasks on conservation of fuel and energy resources were fulfilled, due to which the needs of the national economy for them increased by 43 percent, while the increase of the needs of the machine-building complex for rolled ferrous metals was almost completely fulfilled.

The process of democratization in management of production was expanded. The labor collectives in industry last year elected more than 30,000 workers to management positions, while they elected approximately 6,000 workers in construction. A total of 2,500 associations and enterprises of industry operated under conditions of complete cost-accounting and self-financing. Fulfillment of the plan for product sales with regard to contracts comprised 98.7 percent for these enterprises and was higher than throughout the industry as a whole. Enterprises operating under self-financing conditions efficiently utilized their labor resources, providing an increase of labor productivity with a reduction of the

numbers of workers. On the whole, production expenditures are decreasing at high rates at these enterprises.

An active social policy was implemented sequentially in 1987. The tasks planned by the five-year plan for this year for an increase of the wages of workers and employees, payment for the labor of kolkhoz workers, and payment of public consumer funds were reached or exceeded. A total of 2.3 million new comfortable apartments was constructed through all sources of financing. The living conditions of more than 11 million persons were improved.

However, a significant forward advance was still not achieved in some directions of socioeconomic development. The plan for an increase of national income was not fulfilled and technical progress did not become the decisive factor of public production, while resource conservation did not become the main source of providing a further increase of the volumes of production. Thus, the energy consumption of the national income increased by 0.9 percent in 1987, while metal consumption was reduced by only 1.8 percent, compared to a planned 4.3 percent.

Despite some improvement of the operation of the machine-building complex recently, the situation as a whole was not corrected in its sectors. The output of machine-building products was increased by 4.6 percent compared to a planned 6 percent. Enterprises of Minstankoprom [USSR Ministry of the Machine Tool and Tool-Building Industry], Minlegpishchemash [USSR Ministry of Machine Building for the Light and Food Industry and for Domestic Appliances] and Mintyazhmash [USSR Ministry of Heavy and Transport Machine Building] permitted the greatest lag. The level of contract discipline continues to remain low. In 1987, consumers had a shortfall of more than 12 billion rubles' worth of products and these were primarily machine-building and chemical and woodworking products. Advances of scientific and technical progress are being introduced slowly in industry.

The country's internal development is closely related to the situation in the international arena. The positive results of beginning perestroyka in combination with the initiatives in foreign policy permitted the CPSU to realistically pose tasks to change the world situation for the better. A treaty to eliminate an entire class of weapons was signed between the USSR and the United States in December last year for the first time in the entire history of the build-up of nuclear missiles. The elimination of intermediate- and short-range missiles still does not mean a fundamental break in disarmament. But the beginning of recovery of the international situation has been established.

The year 1988 began to count a new, most important phase of perestroyka and the next 2 or 3 years should decide which way perestroyka is heading. The party and Soviet people are faced in this phase with solution of the two key tasks of democratization of all social life and implementation of radical reform in management of the economy. The

success of the struggle to implement these tasks is largely determined by the Law of the State enterprise (association) and by the plan for economic and social development for 1988, which became effective on 1 January and which corresponds to the strategic course of the 27th Party Congress for accelerating the development of Soviet society, and by the aims of the January and June (1987) plenums of the CPSU Central Committee for fundamental restructuring of management of the economy. Main attention was devoted to strengthening and intensification of positive trends in development of the national economy. According to the 1988 plan, higher rates of growth of social production must be provided than during the first 2 years of the five-year plan. A task of principal importance is solved by this: to intensify the forward movement and stability of development of the economy and to create a reliable basis for fulfillment of the five-year plan as a whole. Essentially the entire increase of the national income this year and of industrial and agricultural products will be achieved through an increase of labor productivity.

Special attention is being devoted to balancing the economy as the most important condition for stable operation of all sectors of the national economy. Industrial production will increase by 4.5 percent and machine-building products will increase by 7.1 percent. The rates of growth of products of the electronic, electrotechnical, instrument-building and machine tool-building industry will be 40 percent higher than for machine building as a whole. The output of high-performance rotary and rotary conveyor lines for machine building will increase 2.1-fold, the output of personal computers will increase 2.4-fold and the output of multipurpose machine tools will increase by 22 percent. On the whole, the increase of product output in the machine-building complex should be achieved by conservation of rolled ferrous metals by 79 percent. The active part of production funds for machine building will triple compared to 1985.

An important feature of the plan for the current year is larger-scale implementation of measures for accelerated solution of social problems and primarily on development of the material base of the social sphere than envisioned by the tasks of the five-year plan. Four-fifths of the national income is directed toward satisfaction of consumer needs. The expenditures on education, science, health and social welfare will increase in the State budget twice as fast than the national income. A total of 8.4 billion rubles more is being directed for strengthening the material and technical base of the nonproduction sphere than is provided by the five-year plan.

During the new phase of perestroyka--a phase of practical work of millions of workers to implement the decisions of the 27th CPSU Congress and plenums of the CPSU Central Committee, the enterprises and associations must convert to full cost-accounting and self-financing and must accordingly restructure the relationships of all sections of the economic system. The workers must be included in production management and in all state and social affairs by democratization. Approximately

20,000 worker collectives (including the entire machine-building complex), which produce 60 percent of all industrial products, are now already working under self-financing conditions.

The existing Law on the State Enterprise creates the appropriate conditions for development of democracy and self-management in labor collectives. This law essentially changes the methods of managing the economy, interests collectives to work economically and qualitatively, and creates objective conditions for the workers to show initiative and enterprise. Now, under conditions of full cost-accounting, the income of each enterprise is directly dependent on the work of its collective. The better the collective works, the higher the remuneration for the results of labor and the higher the part of profits that goes to the enterprise. The new methods of accounting are not compatible with wage-leveling. They become a strong damper to poor workers and loafers.

However, the independence of enterprises still remains incomplete to a known degree. Economic and administrative-team methods of accounting now operate simultaneously and this will become known before the end of the five-year plan. In some cases, the entire production program of the enterprises and associations is filled by State orders, which are not fully supported with material resources and transport vehicles. The enterprises are still operating under the old wholesale price conditions, pricing, material and technical supply conditions, imbalance of standards and violations of their contracts by suppliers. But temporary difficulties are unable to stop implementation of radical reform of management of the economy.

Work on further development of democratization, glasnost, criticism and self-criticism must be activated for final elimination of the braking mechanism. Democracy is not only a means of implementation of perestroyka. The essence of the socialist system, a system of workers and for workers, is implemented by it.

The third year of the five-year plan is of exceptional importance for the fate of perestroyka. A socialist competition has been organized throughout the country for a fitting welcome to the 19th All-Union Party Conference and for successful fulfillment of the tasks of 3 years of the five-year plan.

Universal support of the course of the CPSU is a guarantee of fulfillment and overfulfillment of all our plans.

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URGENT TASK

18610437c Moscow MASHINOSTROITEL in Russian No 4, Apr 88 p 13

[Article]

[Text] The Central Board of the NTO [scientific and technical society] of Agriculture, the All-Union NTO of Machine Builders and the All-Union Chemical Society imeni Mendeleyev considered the question "On Measures to Reduce the Effect of the Road Systems of Agricultural Equipment on Packing Soils" at a joint presidium in January 1988.

Many years of research by the leading scientific institutions of the USSR has established that the structure of the soil is broken down, the density and hardness increase, and the agrophysical and agrochemical properties of the soil deteriorate as a result of the action of the propulsion systems of equipment on the soil. Moisture and air exchange are disrupted with overpacking of the soil, root habitation conditions deteriorate, the tendency toward erosion increases, and effective and potential fecundity of the soils is reduced, which results in a 5-20 percent decrease of the yield and to an increase of fuel expenditures by 15-20 percent for subsequent treatment of it. Packing of soils has a fatal effect when cultivating agricultural crops according to intensive technologies, since high-yield varieties are especially sensitive to the quality of the agrotechnical backgrounds.

The desire to increase the performance of machine-tractor units leads to development of ever more powerful equipment and this is accompanied with no restrictions on the effects on the soil by a considerable increase of the total and specific loads on it.

The problem of negative effects of equipment became especially acute during the 1970's-1980's after heavy wheeled equipment was introduced. The load on the soil increased, since modern multioperational techniques of cultivating agricultural crops require multiple passes of the tractors, combines and trucks over the field. For example, the intensive techniques of grain cultivation require up to 9 passes of equipment over the field during the year and cultivation of sugar beets requires up to 20-22 passes. The resistance to plowing increases by

16-25 percent due to the tracks of caterpillar tractors, the resistance due to heavy wheeled tractors and trucks increases by 44-65 percent, and the resistance due to transport vehicles increases by 72-90 percent.

Calculations show that the decrease in the yield of grain crops may reach 13-15 million tons, while the decrease of the yield of sugar beets may reach more than 2 million tons due to packing of the soil by the tractors, combines and transport vehicles. The additional fuel consumption required for plowing alone may reach more than 1 million tons annually.

A decrease of the negative consequences of the effect of the running systems of agricultural equipment on soils requires integrated solution and includes introduction of technical, agrotechnical and organizational-production solutions. Specifically, technical solutions should envision the improvement of equipment design, development of new types of running systems that ensure permissible effects on the soil, and development of flexible and pneumatic tracks and of low- and superlow-pressure tires.

State Standards, which determine the standards for the effects of propulsion devices on the soil, have now been adopted. The deadline for introducing them onto newly developed equipment is January 1987 and the deadline for all manufactured equipment is January 1996. Scientific and experimental design work to improve and develop new equipment, running systems, flexible and pneumatic tracks, low and superlow-pressure tires and excess loads are being conducted slowly.

Giving important national economic significance to solution of the problem to reduce the effects of running systems of agricultural machinery on the soil, a joint Presidium of the Central Board of the NTO of Agriculture, VNTO [All-Union Scientific and Technical Society] of Machine Builders, and VKhO [All-Union Chemical Society] imeni Mendeleyev feels it is feasible for Minselkhozmash [USSR Ministry of Tractor and Agricultural Machine Building] to increase the output of caterpillar tractors, to satisfy the needs of agriculture for combination and wide-cut agricultural machinery, and to accelerate the development of caterpillar tractors of class 5 and class 8.

Minselkhozmash, Minneftekhimprom [USSR Ministry of Chemical and Petroleum Machine Building] and Gosagroprom SSSR [not further identified] should accelerate investigations to develop and introduce running systems of agricultural equipment with flexible and pneumatic tracks and on low- and superlow-pressure tires and also to find new types of running systems.

The central boards of NTO--of agriculture, machine builders and imeni Mendeleyev--should accelerate the activity of the scientific and technical community in solving the problem of protecting the soil

against overpacking, turning special attention to intensification of propaganda and acceleration of the most important engineering developments on creative and cooperative bases.

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INCREASED PERFORMANCE ROBOTIZED COMPLEX

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[Article by Candidate of Technical Sciences A. I. Yelizarov]

[Text] The standard configuration of a RTK [robotized complex] includes the basic equipment, most frequently a NP machine tool, an industrial robot equipped with universal or special gripping device (ZU), and also a blank holder, and finished product storage.

The presence of two independent devices--a blank holder and finished product storage--in a single RTK should generally be regarded as unfeasible. First, a production area must be allocated to each device and, secondly, installation of them in different locations of the RTK complicates the control program (UP) and requires additional movements of the robot or of its manipulator in the working space and requires additional positioning points of its working member. Moreover, if both the holder and storage are powered, the number of electric or other motors, automation devices, switching devices and so on increase. Therefore, a RTK with separate arrangement of the holders and storage devices can be developed only in technically substantiated cases, for example, if the blank changes its dimensions and shape so much during machining that the design of the storage device must differ principally from the design of the holder, or if the positions of loading the blanks and unloading the finished products should be at different locations or at different levels according to conditions of building in separate RTK into a flexible automated complex, serviced by an intrashop conveyor with program control or by automatic addressing. It is preferable in the remaining cases to configure the holders and storage devices in the same unit.

One angular position is sufficient for the industrial robot manipulator to service these holders-storage devices if the surface for unloading the blanks from the holder is strictly under the surface for loading the finished products of the storage device. This essentially reduces the number of positioning points of the gripping device and simplifies its control program and requirements on the kinematic layout of the industrial robot. The blanks are loaded and the parts are unloaded only

because of lowering of the robot manipulator and because of positive motions of the gripper device along the axis of the manipulator. The simplest industrial robot with cyclic control can perform these motions. Holder-storage devices, combined into a single unit, considerably simplify the configuration of the RTK and improve its performance.

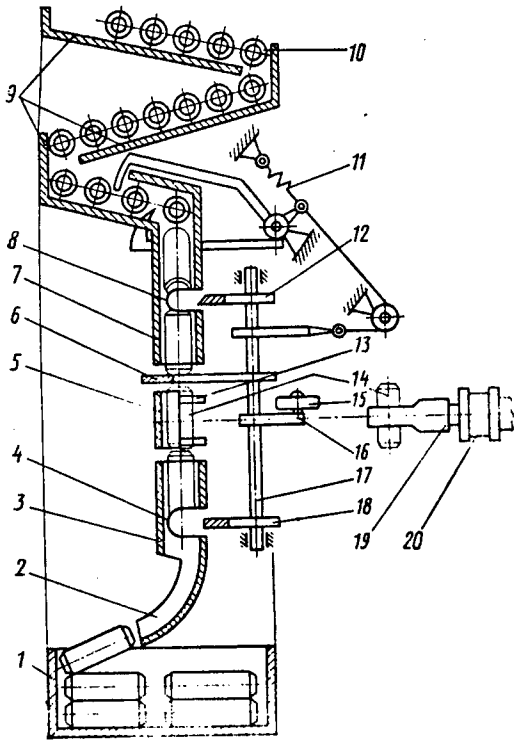

Figure 1

Even higher performance of the RTK can be provided by developing a combination holder-storage device, in which the positions of loading the blank and unloading the finished product are combined (inventor's certificate 1225757). The device operates in the following manner. In the initial position, a four-arm lever 17 (Figure 1) is turned by a spring 11 so that its arms 18 and 12 are brought out of notches 4 and 8 in guides 3 and 7 and do not prevent free movement of finished parts 14 and blanks 10 in them, coming from chute holder 9 by gravity flow. Arm 6 with opposite side notches 4 and 8 drops in under the lower end of tubular blank guide 7, holding the next blank above the blank or finished part loading-unloading zone.

Manipulator 20 brings the next finished part 14 to its unloading zone. The bracket secured to the gripping device 19 presses on roller 15. The roller rotates lever 17 through arm 16, overcoming the force of spring 11. The upper arm 12 enters the notch 8, detaching the next blank from the tubular guide 7, while the lower arm 18 enters notch 4, closing the

guide 3 from below. The gripping device inserts the finished part into unloading zone 14, which moves flexible elements 13 and inserts them into intermediate guide 5. By this time, lever 6 will be moved from under the end of guide 7 and the next blank will be lowered to the support for the finished part. The finished part released from the gripping device approaches the support to arm 18, while the next blank is lowered from above to it, occupying the position in the intermediate guide 5 and in the gripping device. After the blank has been clamped, the gripping device moves away from the holder-storage device, lever 17 is returned to the initial position, the finished part is released by arm 18 and slides along curved groove 2 to the storage device 1. The next blank, released by arm 12, stops above arm 6. The unloading zone is free and ready to receive the next finished part.

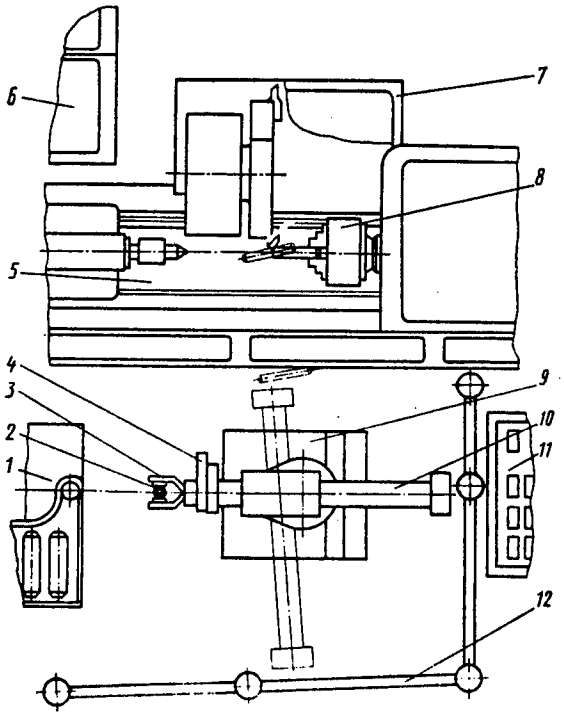

Figure 2

After the manipulator moves away from the holder-storage device, roller 15 on arm 16 is freed, lever 17 is turned to the initial position and the entire device is ready to repeat the loading-unloading cycle.

A typical RTK based on lathe model 16K20F3S5 with NPU device of model N22-1M and with the proposed holder-storage device is shown in Figure 2. The movable enclosure 7 is closed during operation of the RTK in the automatic mode. The NP device 6 is located in front of the machine tool 5, since the operator can freely observe the operation of the device and machine tool and if need be can intervene in their operation. Industrial robot 9 of model Brig-10, holder-storage device 1 and guide

11 of model UTsM-663 are installed behind the lathe. The gripping device 3 of the industrial robot removes blank 2 in the vertical position from the loading position of the holder-storage device upon movement of manipulator 10. The manipulator is then turned toward the lathe and transfers the blank to a position in front of chuck 8, simultaneously rotating it by 90°.

The blank is loaded into the chuck by two movements: by turning the manipulator and by transverse shift of module 4. The finished part is unloaded in opposite order. The short stiff enclosure 12 closes only the working zone of the industrial robot, while the guide and the side of the holder-storage device opposite the industrial robot remain free and accessible to the operator during operation of the RTK both in the training mode and in the automatic cycle. The maximum performance of this RTK is provided by combination of the following factors: enclosure 7 remains fixed during operation in the automatic cycle, the length of movements of the gripping device is minimal, since the manipulator is rotated by only 90° (the angle of rotation of the manipulator reaches 180° or more in ordinary RTK), the positions of loading the blanks and unloading the finished parts in the holder-storage device are combined, which reduces to a maximum the number of positioning points of the gripping device in space and improves the performance of the RTK.

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IMPROVEMENT OF GRINDING OF PARTS UNDER GPS CONDITIONS

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[Article by Doctor of Technical Sciences, Professor Ye. N. Maslov]

[Text] The use of flexible manufacturing systems for manufacture of parts by grinding is fraught with specific difficulties in modern machine building, explained by the need to ensure high precision of machining the parts (to fractions of a micron) at bigh speed of the grinding disk (50-80 m/s or more) with complete automation of the machining processes based on precision NP machine tools, industrial robots and some other automated devices controlled by microelectronics. The grinding machines, operating under GPS [flexible manufacturing system] conditions, should be rigid, vibration-resistant, with especially precise bearings of the grinding disk and feed mechanisms and should have devices for automatic dressing of the disks and active checking of parts during machining.

In this regard, development and introduction of GPM [flexible manufacturing module] and flexible manufacturing systems for grinding still lags behind other methods of machining, for example, for sharpening or milling. At the same time, intensive improvement of grinding is necessary, since the specific proportion of the grinding process will increase with regard to development of precision methods of manufacturing blanks (by stamping, casting and so on) (a forecast of the development of machine-building technology indicates that approximately 25 percent of machining operations now performed on machines with cutting tools will be transferred to grinding by the end of the 12th Five-Year Plan).

An important condition for significant improvement of the efficiency of grinding is concentration (combination) of production transitions, i.e., an increase of their total number during a single setting and reduction of the number of settings (resettings). The given condition is based on one of the theoretical principles of the grinding process, which determines the capability of improving the performance of machining by the maximum number of abrasive grains of the required coarseness acting simultaneously on all the surfaces of the part to be machined. High

performance is provided as a result of simultaneous machining of several surfaces (with the exception of the base surfaces) of complex parts during one setting. This machining is used extensively, for example, in multidisk or combined grinding of shafts on machines operating without numerical program control under conditions of mass production of products.

The great significance of serial machine-building manufacturing, which comprises 70-75 percent of the total volume, made it necessary to work out the fundamentals of modular standardization of parts to be machined with regard to the possibility of effective manufacture of them on NP machines within a flexible manufacturing system and also by designing standard groups of production equipment for machining the parts by different methods, including by grinding. A new technology of high-performance machining of several surfaces of parts during one setting in small series on NP machines within a flexible manufacturing system was developed as a result and is now being improved intensively.

An example may be the completely automated two-spindle precision NP grinding machine of model U80 of the UVA Company (Sweden) with portal robot and with two gripping devices. The blank can be secured automatically and manually. For example, using this machine, one can grind a hole with disk 1 (Figure 1) and two outside ends of the gear block simultaneously with grinding the taper by disks 2 and 3 of different graininess (the base surface is shown by the thin arrows). The grinding disks have rotational frequency of 19,000 min^{-1} on disk 1 and 1,700 min^{-1} on disks 2 and 3. Out-of-roundness of ± 1 μm and surface roughness of the part Ra = 0.15 μm are provided for a hole 25 mm in diameter after grinding. The surface roughness of the taper is Ra = 0.12 μm.

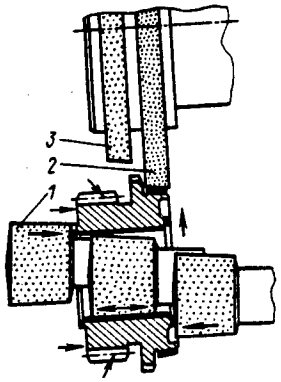

Figure 1

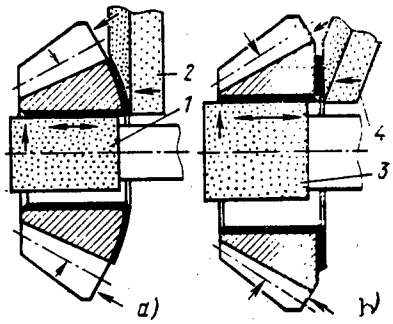

Figure 2

The surfaces and other parts of specific production (modular) type can be machined simultaneously on the given machine tool, for example, bevel gears. In this case, disks 1 and 2 (Figure 2, a) simultaneously machine the hole and spherical end, while disks 3 and 4 (Figure 2, b) simultaneously machine the opening and the flat end. Machine tools of model U80 can be used both off-line and built-in into higher level flexible manufacturing systems.

Specific experience has been accumulated in Soviet machine building on development of NP grinding tools and of robot engineering complexes based on them. One can name as an example the robot-engineering complex, developed by ENIMS [Experimental Scientific Research Institute of Metal-Cutting Machines] with the participation of other scientific research institutes for grinding stepped shafts of normal steel 45 for electric motors, operating at the Electric Machine-Building Plant Dinamo imeni Kirov (Moscow). The semifinished shafts are sent after preliminary machining on a NP lathe for separate machining on one of two NP grinding machines, contained in ASVR-06 or ASVR-07 complexes (the surface roughness of the shaft after grinding is Ra = 1.6 μm).

The main process equipment are two NP machine tools 1 of model 3M15F2 and portal robot 2 of model SMCh0F2.80.01 that services these machine tools in the ASVR-06 complex, the layout of which is shown in Figure 3. The equipment also includes four holders-storage devices 3 (two each for the blanks and parts), an intermediate checking station 4, lighting system 6, control system 5 and other devices. The NP grinding machine of model 3M151F2, used in the complex, was modified and automatically advances and withdraws the tail spindle of the rear mandrel, moves the enclosure of the working zone, clamps the shafts with cylindrical ends and performs other operations. The electrical automation of the complex was supplemented with special devices for the required interaction of the NP machine and industrial robot.

The unit time ($t_{шт}$) comprises 12-15 min when grinding a shaft with 5-8 steps on universal grinding machines. The use of the ASVR-06

robot-engineering complex permits a 3.2-3.5-fold increase of labor productivity per unit time with correct organization of manufacturing compared to machining on grinding tools.

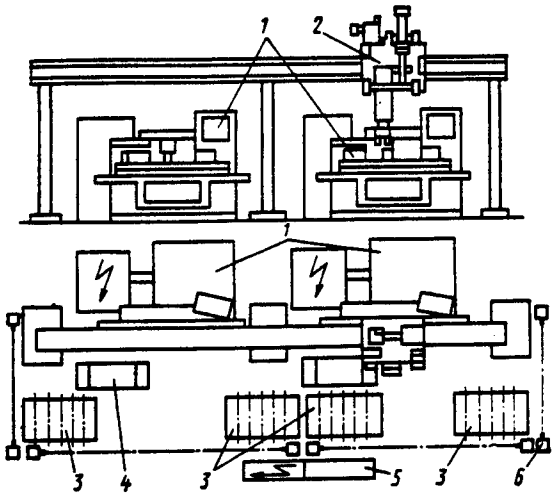

Figure 3

Progressive grinding under FMS conditions envisions the use of high-quality grinding tools--disks (abrasive, diamond, KNB [not further identified])--and efficient use of them. Proper quality of the disks is achieved by increasing the cutting properties of the grinding materials by alloying them and by using optimal binding and other elements of the specifications with the required manufacturing technology.

The use of such new varieties of alloy electrocorundum as zirconium, titanium and chrome-titanium (for machining complex-alloy steels), bar-corundum (for preliminary grinding), and hollow spherical corundum (for grinding plastics) is effective for abrasive tools in FMS. According to data of VNIIASh [All-Union Scientific Research Institute of Abrasives and Grinding], the microhardness of alloyed chrome-titanium electrocorundum increases by 35-40 percent and its abrasive capacity increases up to 53 percent compared to white electrocorundum.

Grinding disks of chrome-titanium electrocorundum 92A on binder K4, which contain 95-97 percent of physical corundum, are used to machine a wide range of parts of different steels (carbon, high-speed, high-temperature and so on) and have good cutting properties at a speed of 50 m/s. Power rough grinding is frequently performed by zirconium electrocorundum 38A disks, which permit one to machine alloy steels at circumferential speed of 80 m/s and with clamping force up to 10^4 N. Compared to similar electrocorundum tools, the given disks permit an increase of machining by 30-50 percent. Highly porous electrocorundum abrasive disks 24A10VM212K5PSS are used to machine stainless and high-temperature steel parts. Polystyrene PSS is used as the blowing

agent during their manufacture. Disks having larger pores are efficient for preliminary (rough) grinding, in which a relatively large volume of metal to be machined, located in the pores of the disk, is removed. Lobed disks are used for shaped grinding and polishing. A surface roughness of Ra = 1.0-0.5 μm can be achieved when machining hardened steel 45 by lobed disks 14A8. Diamond grinding disks are used more widely for boring and lapping of various types of cutting tools of hard alloys, for honing, for lapping and other similar operations.

The presence of KNB and a number of superhard materials based on it (Elbor and so on) made it possible to develop a large group of tools for high-speed and power grinding of different steels (especially hardened steels), including alloy steels--difficult-to-machine steels, sharpening and lapping of high-speed steel tools, various microfinish and other machining, with guarantee of high performance and required product quality.

When using grinding tools on flexible manufacturing modules built into flexible manufacturing systems, special attention should be devoted to standardization according to design formulation and to the dimensions of the base elements of the corresponding tools and also to disks designed for automatic replacement, which is performed regardless of the designation of the basic equipment. Whereas multipurpose machine tools that use both grinding and cutting tools are used in flexible manufacturing systems, their base elements should be fully standardized for locating them in a common tool holder.

The output of precision grinding machines (class A and above), including specialized semiautomatic and automatic machines, is increasing considerably in the USSR. Typical groups of NP grinding machines are being manufactured on the modular-unit principle, which permits flexible configuration of various special or specialized machine tools based on a set of standardized assemblies with independent kinematic circuits and this ensures a high saving, especially with serial manufacture of them.

The efforts of the specialists of a number of CEMA countries are combined in many cases to develop NP grinding machines that correspond to the latest advances of science and technology. For example, we note the flexible grinding module MA-85 for chuck machining of parts of the bodies-of-revolution type with central openings (flanges, disks, pinions and so on), developed by ENIMS and by the Scientific Research Institute of Metalworking Tools (Sofia, Peoples' Republic of Bulgaria). The module includes a NP grinding machine of model ShK 324.32, a portal robot with two gripping devices, a special holder-storage device and other automated devices. The module is also included with the ASV201 flexible manufacturing system, which also includes NP machine tools of other groups (lathe, milling, drilling-milling, boring and drilling), which permit automatic machining of a part of other structures (housing, flat and so on). Several surfaces on the parts, open for access to the cutting tools, can be machined with one setting on this flexible manufacturing system.

The following is required for further improving the efficiency of grinding parts under conditions of flexible manufacturing systems: improving the methods of grinding and polishing with numerical program control for different types of production, improvement of its precision, speed, vibration resistance, flexibility and reliability with broad automation of the production processes that ensure complete replacement of manual labor with machine labor, an increase of the precision, speed and reliability (trouble-free operation) of microelectronic devices for process control in flexible manufacturing systems, and improvement of quality (precision, stability and other parameters) of the grinding tool used in flexible manufacturing systems. It includes introduction of optimal cutting conditions for machining specific parts and development of a reliable base tool for loading-receptacle devices of machine tools and industrial robots, introduction of new effective complete sets of products for flexible manufacturing systems, for example, units for SOZh [oils and lubricants], hydraulic drives, lubrication systems of guide machine tools and so on. This also includes introduction of new electronic modules for control of the automatic grinding disk dressing system, more extensive use of diamond rollers for dressing disks upon mass production of parts and also reduction of the cost of the rollers by increasing the level of automation of their production. It includes introduction of active quality assurance of the machined parts (precision, surface roughness and so on and adaptive control of quality assurance, processing and introduction of new combination methods into flexible manufacturing systems for machining parts (grinding-erosion and so on), further improvement in introduction of new methods of protection of labor and safety when working on grinding machines in the flexible manufacturing system, and development of reliable enclosure devices and provision of trouble-free operation of light signalling.

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HOW TO ENLIVEN COST-ACCOUNTING

18610437f Moscow MASHINOSTROITEL in Russian No 4, Apr 88 pp 36-37

[Article by Candidate of Economic Sciences V. K. Chunikhin]

[Text] It is written in the USSR Law "On the State Enterprise (Association)": "The customer's requirements are obligatory to the enterprise and their complete and timely satisfaction is the highest meaning and standard of activity of each labor collective." Fulfillment of this important condition requires that new estimate criteria be worked out which provide transition from incentives "for the level of fulfilling the plan" to incentives "for the quality of utilization of resources and servicing of the customer." The integrated plan of the enterprise, directed toward an increase of production efficiency, should mobilize the collective to implement reserves and to improve customer service, to improve product quality, and to introduce scientific organization of labor, new equipment and scientific research work. The practice of working out plans of different content (organizational and technical measures, technical development of an enterprise, the technical plan and so on) should be eliminated, since attention is diverted from the main goal--to find reserves for improving the quality of customer service. Let us dwell in more detail on this.

The labor, material and fuel and energy resources of an enterprise together form a structure that supports more complete satisfaction of the customer. In turn, an increase of needs interdependently induces a need to increase resources. Improvement of cost-accounting and introduction of scientific and technical progress and discoveries permit one to reduce the expenditure of labor and material resources while satisfying growing needs. Study of the principles of improving the quality of customer service while reducing resources per unit need, we feel, will make it possible to predict the deadlines for achievement and surpassing the quality of worldwide models. Combining and planning cost-accounting into a single mechanism permits one to accelerate this process.

Thus, an indicator of the cost-accounting activity of an enterprise is arbitrarily assumes the ratio of available resources and of those

utilized in fulfilling the plan, by which is explained the interest in an understated plan or correction of it. It is natural that the plan should take into account the maximum possible use of resources: the fewer resources the enterprise uses under the same conditions of fulfilling the optimal plan, the smaller the difference between the required and recruited resources. The optimal "design" of the economic mechanism and incentives for reduction of utilized resources was worked out at the Sumy Machine-Building NPO [scientific production association] imeni M. V. Frunze. With the significant difference of recruited and required resources, the work to improve the organization of production under cost-accounting conditions should be directed toward implementation of reserves or toward "curtailment" of unprofitable plants, and if there is an optimal ratio of resources, it should be directed toward finding them. The ministries play the decisive role under conditions of the new relationships with the enterprises based on cost-accounting, when the workers of the enterprises and ministry are encouraged from the results of the effectiveness of the manufactured product. The process of finding new reserves for an increase of production efficiency through planning corresponds to the goal of the most complete satisfaction of needs. Self-financing of enterprises under cost-accounting conditions of the sector is directed toward a universal search for production reserves (the enterprise workers are rewarded), serves as optimal redistribution of resources (ministry workers are rewarded), and permits one to raise to a new higher level production efficiency in customer satisfaction. By linking the resources and goal of more complete satisfaction of needs, the structure assumes the presence of relationships between the elements of resources: labor, materials, equipment and so on. The quality of the links between elements and the level of their development determine the labor-intensiveness of the product.

The experience of machine-building enterprises of the sectors shows that the most promising is a reduction of the labor intensiveness of products by improving the organization of auxiliary operations using ASU. To achieve this, the following reserves can be utilized:

development of cooperation, for example, in support with spare parts, tools and materials (the experience of the multichannel supply system of the Hungarian People's Republic);

introduction of intersector maintenance complexes, for example, in fulfillment of transport and repair operations (the experience of the USSR and GDR on interaction of local organizations and enterprises);

implementation of a number of measures that ensure output of high-quality products (design and optimization of block and schematic diagrams on quality assurance).

How can these reserves be implemented in the work of sector enterprises under cost-accounting conditions? To do this, having studied the

reserves at sector enterprises under the viewpoint of cost-accounting development and basic propositions of the Law on the enterprise (Association), priority directions of their development are established. Measures to implement the reserves and for the enterprises to receive additional profits (with regard to Soviet and foreign experience) are then determined according to the structure of the resources.

For example, studying and establishing the causes of disruption of product deliveries by the enterprise, low product quality and so on, the potential reserves for increasing profits under cost-accounting conditions and in orientation toward the customer are seemingly determined. These causes are most frequently breakdowns in supply of materials and tools, idle times of equipment due to the absence of spare parts and so on. Illumination of these deficiencies will permit the enterprise, for example, to increase the material incentives fund by 15 percent while fulfilling the agreed plan by 100 percent. In another version, a bonus at the level of 30 percent of the wholesale price can be established for output of a highly efficient product by the enterprise with an increase of quality.

Analysis of the other questions, for example, idle times of equipment due to a lack of spare parts, shows that solution of the given problem is specifically related to a shortage of repairmen, decentralization of the repair service and so on. Therefore, the named deficiencies must be considered when solving it as the result of available reserves at the enterprise for improvement of cost-accounting activity. Various types of obsolete equipment frequently does not correspond in characteristics to the task of manufacturing high-quality products. For example, study of the possibilities of standardization of products with regard to their manufacturing technology on the basis of utilization of work place certification data and functional cost analysis permits changes in the design of products and correction of the production process, optimization of the structure of the machine tool stock (adjustment of technology to equipment), permits a reduction of the nomenclature of spare parts and, accordingly, permits an acceleration in manufacture of them. This makes it possible to centralize the repair service and to reduce the need for highly skilled repairmen, which is a prerequisite of organizing serial repair under conditions of territorial cooperation. Having adjusted the technology to the equipment, we thus optimize the coefficient of allocation of the number of operations and we thus increase the size of the lot, which reduces the cycle and net cost (by reducing the number of readjustments and preparatory-closing time), it will improve planning conditions, and will increase the guarantee of rhythmic product output. The given example is only an illustration of the seemingly horizontal relationships of resource elements in the "resources-target" structure. They can be "structured" in any other order with respect to the goal and conditions of production. It is important that the reference point be an increase of production efficiency with orientation toward the final goal--maximum satisfaction of the customer.

Similar to how a part is considered from different aspects, we see its different outlines and cost-accounting has different possibilities of reducing expenditures with respect to the result. Thus, besides horizontal improvement, there can be vertical improvement of organization for one of the resource elements (for example, improvement of support with equipment) on the following levels: work place (brigade), section, ship, enterprise, sector and the national economy as a whole.

We feel that it is most important during vertical improvement that the indicator correspond to the level at which it is formulated. Whereas the indicators for the main and auxiliary product should be integrated along the vertical into the same goal, they should differ along the vertical, since the brigade, to be able to adjust, should receive detailed information as to what and how it can conserve. Therefore, besides the methodical materials on cost-accounting of indicators of conservation of tools and materials (in pieces and by mass) in sector procedural materials, indicators of their conservation as a result of improving the organization of production and of using the more progressive technology and introduction of automation should be indicated. For example, the following can be named among the indicators of conservation of materials: ease of storage at the work places, equipment and accessories for fast attachment during machining, capability of reducing labor intensiveness. The indicators for conservation of tools should include: improving the quality of sharpening, observing the cutting conditions, reducing replacement time, and adjustment of tools and equipment. Similar experience was accumulated at the Leningrad Machine Building Production Association imeni K. Marks and at the Plant Lenpoligrafmash. The effectiveness of tool utilization both through optimization of cutting conditions and through conservation of time upon attachment of the tool and blanks by using pneumatic and hydraulic clamps and methods of efficient storage and delivery of tools are increased at these enterprises. Organization of the relationships of machine tool operators and workers involved in supply of tools is being improved.

Other indicators: improving the storage conditions and issue of tools and materials, the use of more stable materials, checking and developing regulations for correct use of tools by machine tool operators, and responsibility for timely support of the work places with high-quality tools are typical for the tool shop and enterprise as a whole.

Before establishing cost-accounting indicators at sector and intersector levels, the sources of the greatest reserves of labor and materials resources can be determined and then, having established the indicators, working out measures on implementation of these reserves up to the work place level. For example, this can be indicated by comparing the effectiveness of outfitting uniform tool production products on the basis of normative accounting of expenditures and net cost of manufacture. The increase of labor productivity by reduction of labor intensiveness of the production process will be this indicator in basic

production, while reduction of specific expenditures for manufacture of equipment in the final product of the enterprise will be the indicator in auxiliary production. Profits are distributed according to the indicator of the reduction of the labor intensiveness of a product and according to the contribution of the shop to improve its qualitative characteristics at the enterprise, shop and service level. Awarding bonuses at the level of work places and brigades is achieved on the basis of regulations on incentives for conservation of labor and material resources. Thus, the relationship of indicators by levels (work place, brigade, section, shop and so on) assumes that the maximum possible useof a given resource (for example, equipment) will be achieved with orientation of the customer toward the final goal.

Thus, the integrated system of automated accounting of the use of labor and material resources, related to the rhythm of product output, developed by employees of VNIIElegpishchemash [not further identified], can be established as the basis of the cost-accounting mechanism of the enterprises of the sector. As experience showed, a common reserve for all enterprises is the possibility of optimizing the expenditures and results on the basis of improving the organization of basic and auxiliary operations.

Introduction of a standard accounting system for utilization of production resources makes it possible to build a structured cost-accounting system of rewarding the labor collectives at each enterprise for the results of implementation of measures, directed toward an increase of profitability and toward improvement of product quality. When evaluating collectives from the results of an increase of profitability of production and reduction of the level of actual and optimal-planned expenditures, an extensive reserve for stimulation of the output of high-quality products is improvement of the organization of auxiliary operations (an increase of check efficiency, improvement of tool support and so on).

The cost-accounting activity of the labor collectives of enterprises should be stimulated from the results of comparing the actual and optimal expenditures of manufacturing a product with regard to its evaluation by the customer during operation. This approach creates a qualitative basis for predicting important discoveries and inventions. The mechanism of distribution of incentive funds of enterprises under self-financing and self-supporting conditions should provide a continuous increase of the reliability of products and improvement of the quality of customer service during operation of them (organization of company repair and reduction of its labor intensiveness, an increase of the network of service centers according to the experience of VAZ [Volga Automotive Plant], and support with spare parts, including models taken out of production).

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AUTOMATED PROCESSING OF FINANCIAL AND CREDIT DATA IN MACHINE BUILDING

18610437g Moscow MASHINOSTROITEL in Russian No 4, Apr 88 pp 37-39

[Article by economic engineer I. Yu. Sysoykina]

[Text] The development of credit relationships with the bank for all sectors of the national economy has recently become dynamic in nature. This is especially important under conditions of acceleration of scientific and technical progress, since the use of borrowed funds will save time. The machine-building sector is the most credit-intensive.

Intensifying the role of the financial and credit mechanism in intensification of the machine-building industry requires that management of finances be improved in all its cost-accounting sections and primarily at the enterprise itself under ASUP [automated enterprise management system] conditions. Problems of automation of financial and credit calculations have until recently fallen out of the purview of both the clients and developers of ASUP in the entire importance of financial and credit data on the economic activity of enterprises.

There are a number of papers in which different aspects of management are considered, based on the use of economic and mathematical methods and computer hardware. However, almost all of them are devoted to individual aspects of the production process: to improvement of technical and economic planning, to bookkeeping and accounting, to material and technical supply and to sales. The natural real indicators and the relationships between them are mainly subject to automation. Individual problems of management of supplying credit to industry have been solved at the enterprises, but practice showed that this was done on an insufficiently developed database--the base on which the movement of monetary funds occurs. The consequences of these underfulfillments have a negative effect on the operating efficiency of many ASU, since the production and financial indicators must be considered together for a successful result of automation of many tasks.

Analysis of automation of financial and credit calculations at some machine-building enterprises showed that these problems have been very poorly worked out. Therefore, generalization and dissemination of leading experience, accumulated by some enterprises, is very timely.

The modern machine-building enterprise consumes materials, purchased products, parts, and semifinished products of thousands of nomenclatures. The economic experiment advanced the problem of underutilized and above-norm residues of goods and material valuables, since an improved credit rating is taken from them. The use of modern computers for solving the tasks of a financial check of the status of standardized circulating funds acquires great timeliness. The experience of automation of financial checking at some automotive enterprises using a special classifier of the causes of underfulfillment of the plan (76 codes), which encompasses almost all areasof the economic activity of the enterprise, is indicative. For example, there is an absence of funds for raw material or materials (code 01), there is late delivery of raw material or materials from suppliers according to allocated funds (code 02), there is late payment for shipped products (code 07), there are changes in the variety of manufactured product (code 33), there is underfulfillment of the production plan (code 57) and so on. Solution of problems for this type of financial checking not only assumes automation of checking of the status of nonliquid and surplus material valuables, but also permits one to tie the production and material and technical supply plants to the activity of the financial department of the enterprise.

The automated automotive numerical accounting subsystem, which gives current information in real time about the finished product and surpluses of uncompleted production according to different reasons with different periods of delay of the surpluses (more than 3 months, 2-3 months, 1-2 months, 15-30 days), introduced at the automotive enterprises, is of interest. One of the most active users of information received from the enterprise computer center is the financial department, which calculates the need for credits on its basis and monitors the use of credits.

The financial apparatus gives important significance to planning of borrowed funds, required by the enterprise, and to current checking of their use. Therefore, tasks which permit the financial department of the enterprise, without expending much time on calculations, to remove from delivery previously planned surplus material valuables, should be solved for compilation of a qualitative credit plan for purchase of material valuables. Automation of data processing in this section of work is of important significance, since poor quality determination of the need for credit for payment of material valuables will have a negative effect on relationships with the bank.

The experience of introduction of many leading ASUP indicates the individual unresolved problems, related to automation of receiving financial and credit information. The success of cost-accounting enterprises is largely dependent on active use of modern scientific methods, including economic-mathematical methods using computer technology. There is a need for an economic and mathematical apparatus that permits a current check of the substantiation of applications for circulating funds.

The use of statistical methods, specifically, of regression analysis methods, yields specific possibilities. By knowing the number of input factors

$$x = (x_{i_1}, x_{i_2}, \ldots, x_{i_n}),$$

where n is the number of factors which are the causes of underfulfillment of the plan, one can predict the optimal value of the standard of circulating funds. The dependence of standard circulating funds y_i on regressors can be expressed by the following equation:

$$y_i = a_1 x_{i_1} + a_2 x_{i_2} + \ldots + a_n x_{i_n} + \Sigma_i,$$

where a_1, a_2, ..., a_n are regression coefficients and Σ_i is the error. Since the significance of any of the factors is different for each specific enterprise, the dependence of each factor on the standard of circulating funds must be determined and the most significant factors must be selected for constructing the regression equations.

Introduction of this multifactor model helped to predict the standards of circulating funds at some machine-building enterprises, which differed from the actual value by only 12.3 percent. Automation of calculation of the planned standard of circulating funds as a result of processing a large volume of information, contained in preliminary documents (warehouse card indexes, contracts with suppliers and so on), yields an error of 27.3 percent by direct calculations on the basis of last year's data. Unfortunately, the economic and mathematical apparatus in automation of financial calculations has still not found the proper dissemination in even the most advanced ASUP.

Estimating the feasibility of using economic and mathematical methods and computers in management of enterprise finances, one can establish two mutually related directions: improvement of the activity of the enterprise as a result of the use of economic and mathematical methods and computer hardware in a given segment of operations within the ASUP and improvement of the economic mechanism of the enterprise as a result of interaction of the ASUP and ASU Promstroybank of the USSR. Implementation of this completely automated interaction of the enterprise and the bank will provide currentness in study of bank workers of the enterprise's financial activity and timely accounting of resulting deviations. One of the methods of improving and increasing the quality of bank checking is efficient organization of it, when automated economic data processing is used at industrial machine-building enterprises. Using the terminal, the inspector can selectively check the reliability of the database, the timeliness of its updating, and if need be, can receive a document in a form convenient

for checking upon request when an automated data bank functions at an industrial enterprise.

It is important to select correctly the hardware in full conformity with the tasks to be solved, with the volume of data to be processed and with the diagram of interactions of indicators for implementation of such completely automated interaction of the enterprise and bank under conditions of the ASUP. Investigation of the structural and information characteristics of the complex of tasks for planning the needs for credit and checking the use of them at machine-building enterprises led to the conclusion that they can be solved on the basis of mini- and microcomputers within the distributed data processing system, for which automated workstations (ARM) of workers of the financial services of enterprises and institutions of Promstroybank, which monitors these enterprises, should be developed.

The development of microcomputers, intelligent terminals, and specialized languages, and also transfer of data over communication channels in multicomputer networks and transition to distributed data processing created everything necessary to equip the workers of the financial services of the enterprises and bank economists with professional ARM. Mini- and microcomputers are now used extensively in plant technology management automation systems (ASUTP). The use of them for solving management problems is still unit in nature, although in practice, the use of small computers considerably reduces the expenditures on data processing. This is determine by the low cost of small computers, by the simplicity of maintaining them, and by the possibility of local data processing without access to a central computer. The use of mainframe computers, oriented toward centralized data processing, leads to underutilization of their computing resources, to a delay of reporting, and to the complexity of real-time management in this subject area.

The use of an ARM by the accountant of an enterprise and of an ARM by the bank economist within the system of interaction of the ASUP and ASU Promstroybank requires software for their optimal functioning, development of which is complicated due to the difficulties of formalized description of man-computer interaction.

The following requirements are placed on the ARM of economists at industrial enterprises and in bank institutions:

ease of working with a terminal;

capability of working with a computer in the interactive mode;

representation of data in the form of tables;

the capability of working in a computer network.

The desire to represent data in the form of tables is related to the fact that economists have used paper forms long before the appearance of computer technology. It is assumed that in the future, a universal means of man-computer communications will become AI software-hardware. These devices will be able to communicate with specific specialists after the corresponding adaptation in terms of specialty (designer, bookkeeper, account and so on). The "screen" language of documents may now emerge as this means. The concept of transfer of paper forms to "screen" documents is being developed intensively, since the language of documents is very familiar to any economist. Therefore, when talking about arbitrary querries of the end user economist, one can talk about the desire to obtain specific characteristics of credit facilities in documents of specific form. The number of these documents is limited in practice and usually does not exceed several tens. The following scheme of user-computer dialogue can be suggested on this basis:

the user selects the document that he requires on the basis of selection from a list of documents;

the names of the credit facilities which the user should fill in are illuminated on the display screen;

the computer codes the names of the credit facilities, conducts a search for all characteristics of this object in the database of the ASUP, makes the required computations and formulates the document. This interactive scheme is very simple, the operating mode is convenient for the user and it is perceived as a dialogue in natural language. In the given case, the capability of the computer to satisfy all information requirements of the user economist rather than the intelligent capabilities of the computer are important.

The following interactive modes should be implemented during interaction of the ARM of the economist of Promstroybank with the data bank of the ASUP:

an "Electronic document" is formulated upon request of the enterprise accountant as a result of interaction with the ASUP database (within the local area network of the ASUP). "Electronic mail" transfers the document to the end user (the economist of Gosbank).

an "Electronic document" was formulated at the request of the bank economist as a result of interaction of his ARM with the ASUP database (access to the remote ASUP database for receiving the "electronic document" on the display screen at the bank is suggested).

This orientation toward operation of an existing ASUP in the interactive mode will considerably reduce the production cycle of data processing and will increase the effectiveness of organizational forms of interaction of the enterprise and Promstroybank.

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USE OF WINDMILLING VANE RINGS IN TURBOMACHINES

18610116a Moscow ENERGOMASHINOSTROYENIYE in Russian No 12, Dec 87 pp 5-8

[Article by V.L. Zhokhov, candidate of technical sciences]

[Abstract] Use of guide rings with windmilling vanes in gas turbine engines is considered, the purpose being to stabilize flow conditions at the stage entrance and thus improve the efficiency as well as the economy of machine operation. An experimental study of a K-70-17M axial compressor with such guide rings before the runner was made, three guide rings with different vane profiles and tilt angles being tested under flow conditions with the Mach number N_M = 0.19-0.22 and the Reynolds number $N_R = (0.18\text{-}0.22)\cdot 10^5$. Specific pressure head, efficiency, and specific speed were measured as functions of the flow coefficient over its 0.05-0.5 range, the results indicating separation flow within the 0.27-0.33 range with each ring. These performance characteristics indicate a large improvement over performance without such a guide ring but little difference between the three of them. It is nevertheless necessary to custom design such a guide ring for a specific machine and for specific service conditions. Figures: 4; tables: 1; references: 18 Russian.

2415/9365

UDC 531.383

PERTURBED ROTATIONS APPROACHING LAGRANGE REGULAR PRECESSION OF SOLID BODY

18610218b Moscow MEKHANIKA TVERDOGO TELA in Russian No 6, Nov-Dec 87 (manuscript received 15 Jun 86) pp 8-17

[Article by D.D. Leshchenko, Moscow, and A.S. Shamayev, Odessa]

[Abstract] Rotation of a dynamically symmetric solid body about a fixed point inside it under a perturbing and a restoring moment is described by the Euler equations. Projections of the perturbing moment on the three principal axes of inertia are assumed to be known periodic functions of the three Euler angles, functions of time, and functions of the three projections of the angular velocity vector on those axes. They are also assumed to be much smaller than those of the restoring moment, which implies approaching the Lagrange case. This system of six equations is solved for a body rotating with an angular velocity sufficiently large to make its kinetic energy much larger than its potential energy and with the direction of the angular velocity vector sufficiently close to the axis of dynamic symmetry to make its projection on the other two axes negligibly small. The averaging procedure involves a change of variables upon introduction of a small parameter-multiplier, considering first the zeroth-order approximation with that parameter set to zero, reintroducing it, and more changes of variables with eventual transformation of the system of equations into one of seven convenient for asymptotic solution. Some special cases are considered: rotation of a body with a cavity filled with a high-viscosity fluid, rotation of a body in the presence of linear external dissipating moments, and rotation of a body by action of a small constant perturbing moment.

The authors thank F.L. Chernousko and L.D. Akulenko for formulating the problem and for helpful discussions. References: 13 Russian.

2415/9365

UDC 531.8

DYNAMICS OF SMALL MOVEMENTS OF WALING APPARATUS WITH REACTION FEEDBACK FROM SUPPORTS

18610218c Moscow MEKHANIKA TVERDOGO TELA in Russian No 6, Nov-Dec 87 (manuscript received 27 Feb 86) pp 39-47

[Article by D.M. Gorinevskiy and A.Yu. Shneyder, Moscow]

[Abstract] Small movements of a generally N-pedal and specifically 6-pedal walking apparatus about its equilibrium position with reaction feedback from the supports are analyzed, such an apparatus constituting a statically indeterminate mechanical system. The corresponding Lagrange equations of motion in generalized coordinates are derived from the applicable expressions for kinetic energy and potential energy, upon introduction of the Rayleigh dissipation function. The characteristic equation and particularly the behavior of its roots are analyzed for dynamics and stability of movements of "rigid" legs, then on "isotropic" legs. The analytical results as well as numerical results pertaining to a dynamic model of a rectangular body on identical legs are found to correlate with experimental data on the amplitude-frequency and damping characteristics of such an apparatus, fast movements and slow movements being treated separately on account of essential differences. Figures: 1; references: 21 (15 Russian, 6 Western).

2415/9365

UDC 531.8:534

ONE METHOD OF ANALYZING NONLINEAR BOUNDARY-VALUE PROBLEM FOR DYNAMICS OF BIPEDAL WALK WITH IMPULSIVE CONTROL

18610218D Moscow MEKHANIKA TVERDOGO TELA in Russian No 6, Nov-Dec 87 (manuscript received 8 Apr 85) pp 49-52

[Article by S.V. Martynenko, Kiev]

[Abstract] Controlled movements of a bipedal apparatus, a mechanical system of hinge-joined physical pendula, are treated as a nonlinear boundary-value problem. Control impulses are applied during periods of standstill on bipedal support and motion about unipedal support proceeds by inertia. The corresponding system of equations of motion is closed by boundary conditions of the first kind stipulating repeatability of member positions after each step. The problem of dynamics from initial state to final state is solved in successive approximations, the zeroth approximation with the eigenfunctions having been selected for an industrial robot and not more than three solutions, symmetric trivial ones and asymmetric nontrivial ones, having been obtained by the Bogolyubov-Mitropolskiy asymptotic method with up to third-order nonlinearities taken into account. The solutions are further analyzed on the basis of corresponding variational equations, 25 solutions being possible but only 2 symmetric nontrivial ones satisfying the condition of smallness so that the first approximation appears to be adequate. Figures: 2; references: 4 Russian.

2415/9365

UDC 531.36

FREE MOTION OF ELASTIC ELLIPSOID

18610218e Moscow MEKHANIKA TVERDOGO TELA in Russian No 6, Nov-Dec 87 (manuscript received 13 Nov 85) pp 69-74

[Article by G.G. Denisov and V.V. Novikov, Gorkiy]

[Abstract] Free motion of an elastic homogeneous ellipsoid relative to a system of coordinates rotating at a constant angular velocity is analyzed, this system of coordinates having its origin at the center of mass of the body and been selected so that the body as a whole does not move relative to it. The state of stress and strain is calculated in the quasistatic approximation, with components of the strain vector in polynomial form containing only terms linear and cubic with respect to space variables so that a nontrivial solution exists and the two volume integrals of material change are automatically equal to zero. References: 6 Russian.

2415/9365

SCIENTIFIC-TECHNICAL PROGRESS AND UPDATING MACHINES AND EQUIPMENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA in Russian
No 6, Nov-Dec 87 pp 88-93

[Article by A.V. Shubrta (Czechoslovakia): "Scientific-Technical Progress and Updating Machines and Equipment"]

[Annotation] In the article, the author continues the discussion of the problems raised in the publication of R.L. Rayatskas and A.P. Yalinskas concerning a definition of the optimal periods for updating basic stock (fixed capital). A method is proposed for determining these periods, which is suitable for the present stage of development of the economies of the socialist countries. Particular attention has been given to the problem of considering the obsolescence of basic stock.

[Text] The article "Determining the Optimal Service Life for Machines and Equipment" (by R.L. Rayatskas and A.P. Yalinskas) was published in the journal SERIES ON ECONOMICS No 6 of 1986. The problem of optimizing the regeneration cycle of machines and equipment is of the utmost currency, particularly in relation to modernization and reconstruction, the value of which has grown significantly in recent times. This article develops certain concepts which are contained in the above article, and may be boiled down primarily to the question of what are these "natural," or "optimal" rates for updating capital stock which conform to the actual rate of technological progress, and what are the consequences of not observing them. The difference revealed between the "optimal" and actual updating of machines and equipment and mechanisms may indicate to what degree the economic mechanism corresponds to the requirements of scientific-technical progress, and to the achievement of a maximal social effectiveness of production.

Recently, in regard to scientific-technical progress one often hears about the basic factor of intensification, by means of which it is possible to obtain a far higher rate of growth in economic efficiency. However, in practice it is often forgotten that the growth of economic efficiency is primary and that scientific-technical progress should to a significant degree be tailored to this criterion.

In reality, scientific-technical progress may not be realized without the replacement of the basic means of production. Here the question arises of

when to expediently replace old principal means of production with new ones (moreover, this replacement may also be conducted, for example, through modernization and reconstruction). In all probability, in this case the generation of new products will also be realized.

At different stages in the development of socialism, certain inherent reasons have arisen for replacing old equipment with new. The most important reason for updating the basic capital stock was the technical unsuitability of such stock for further utilization or we may say, a shortage of resources (for example, a shortage of manpower creates the need for liquidation of basic resources with low productivity, a lack of spare parts often prematurely forces the termination of the use of a portion of the basic stock, and the limited capacity of the environment leads to the need for liquidating more "dirty" forms of production).

However, it is very likely that not one of the reasons indicated above is directly related to the process of intensification of the national economy, at any rate in the form that it has recently appeared, leading to conditions of a fundamental restructuring [perestroika] of the economic mechanism. It should not be said that the indicated reasons for updating basic capital resources do not have anything in common with efficiency, simply that efficiency is manifested in them only indirectly, and may be significantly distorted. During intensification, the decisive and direct criteria for updating equipment should be those related to the growth of the social productivity of labor, which in reality is the main source for increasing the level of economic development of society (in the long term).

However, due to the fact that in practical calculations it is difficult to start from this criterion, it is evident that some sort of more partial index which would be easier to calculate should be used. For example, if we take as a criterion the so-called productive-economic efficiency, then using a system of different socioeconomic standards (for example, laws for preserving the environment, taxes, duties), by actively using prices it is possible to achieve a close connection between this factor and the social or national economic efficiency.

Consequently, it may be assumed that under the condition of the intensification of the national economy, those changes in the economic mechanism may be successfully implemented for which the potential arises that individual actors in the economic sphere (enterprises) will, through making decisions, be able to be subordinated to a common criterion, which should meet the requirements for reducing the consumption of social resources (with the satisfaction of the needs of society). Insofar as this has not yet occurred, the categories "cost," "price," etc., will be used below only as standard and general terms.

From general concepts indicated above it is evident that during decision making concerning the optimal moment for updating basic stock, the criteria for the maximization of the social productivity of labor "requires" the minimization of the relative importance of the overall quantity of social labor which is expended for the entire service life of equipment, and in the overall cost created in the equipment over the time of its "existence."

We will not dwell on questions linked with the limited nature of resources, because they represent the effects of a particular stage of development. it is highly likely that during the transition to the stage of intensive development, the majority of complaints concerning the limited nature of resources and the related possibilities of future development will disappear. It is true, and cannot be ruled out, that other critical "areas" will arise, but it is as yet not clear where these might be.

The main agent of intensification, scientific-technical progress, is manifested in the process of regenerating the "mechanical" portion of the basic resource stock, in the first place as the proposal of new technology, with productive parameters that are in line with contemporary levels. As a rule, such technical progress means that the relative costs of production (without amortization) are reduced for the new machinery.

The causes of the obsolescence of basic capital resources facilitate their rapid updating. The value of basic capital resources is gradually "transferred" into the value of the produced product. The transferred cost per unit of production will be lower, the greater the time it was produced on a given piece of equipment, i.e., the more prolonged the operating time of the basic resources. The problem involves finding the optimal moment for updating equipment (topt), when both components (i.e., the average losses as a result of obsolescence and the transferred value of the basic resources per unit of production) will be at a minimum.

The categories of obsolescence were developed by K. Marx. Theoretically, in a planned socialist economy, an estimation of obsolescence is based on the analysis he conducted. However, in practice, the obsolescence of basic capital stock is evaluated primarily by means of a comparison of only the consumption values (productivity) of basic capital stock with an identical function. Often only the technical and economic parameters of domestic technology are compared with the most advanced foreign technology. during such an evaluation, not only are the economic aspects of the problem not considered, but also, in general, the evaluation makes it possible to consider the bulk of our basic capital stock obsolete. Such a method for evaluating obsolescence is completely erroneous from a theoretical standpoint.

From the preceding discussion it follows that the optimal moment for updating stock may be determined using the equation

$$\min_t Z = \frac{K}{t} + \frac{1}{t}\int_0^t (S_0 + ct)dt \qquad (1)$$

where Z is the average cost over 1 year for the operation of the equipment; K is the expenditure in its acquisition; t is the service life for the equipment (K/t is the equipment amortization); S is the fixed expenditure in production; c reflects both the increase in expenditures over time (for example, in repairs), and mainly, the increase in losses as a result of obsolescence or losses related with the appearance of the potential for

reducing the socially necessary labor in the production of a given product (concerning such a reduction of the socially necessary expenditures, it is possible to cite, for example, a reduction in prices, while in the absence of price "signals," an indirect sign is the improvement of the technical parameters of another available technology, which could replace the existing equipment).

New equipment requires less outlay per year for production (without amortization) than the previous equipment by the factor c. Because such an effect accumulates, the outlays in production during operation on equipment which is 5 years newer than the previous equipment, will be lower by the quantity c*t over the operating period (without amortization).

Equation (1) is formally identical to equation (2) presented in article [1], though the authors note that they are only evaluating physical wear. From the above it is clear that this equation may also be used for evaluating the obsolescence.

By solving equation (1), we obtain (after deriving over time t and setting the results equal to zero)

$$t_{opt} = \sqrt{\frac{2K_0}{c}} \qquad (2)^1$$

In article [1], this calculation method is proposed for use in the case where the losses (the expression under the integral sign in formula (1)) are exponential and not in linear form, viz. $Y = S_0 + ct^{\alpha}$. In this case we obtain the result

$$t_{opt} = \sqrt[\alpha]{\frac{\alpha + 1}{\alpha}} \frac{K_0}{c} \qquad (3)$$

In order to use the results calculated using formulas (2) and (3), it is necessary to decide if K_0 is the initial or updated value. In article [1] the authors attempt to give an answer to this question, though it is not altogether adequate. In all probability, those outlays in production should be considered, because due to the amortized deductions, sources of reproduction should be created, i.e., the category of socially necessary expenditures should include expenditures on the necessary reproduction of basic capital stock. However, we will not dwell further on this problem. Instead we will attempt to consider other consequences related to obsolescence.

1. The authorship of formula (2) is often attributed to the American economist D. Terborg. In [2] it is shown that the result during calculations with formula (2) does not change even in the case where a factor expressed in percent of the value of the equipment is introduced into equation (1).

Nonobservance of the optimal service life causes the expenditure of excess labor. Selection of the optimal service life makes it possible (in the satisfaction of a given need) to expend the minimum quantity of labor (with

the existing rate of technical progress). Therefore, the argument that society does not have sufficient resources in the capital investment needed for observing the optimal service life is highly debatable. Any nonobservance of the optimal service life (i.e., the maximum efficiency of updating) leads to a large expenditure of labor, which means eventually it will lead to the depletion of the resources available to a society for distribution, and consequently, to a reduction in the sources of future capital investment. Clearly, it may be concluded that a certain "natural," quantity of capital investment directed to updating the basic capital stock corresponds to each stage of the intensity of technical progress. If society does not allocate the necessary resources, at a minimum, it should realize what cost must be paid and how this will be harmful in the sphere of the productivity of labor. It may not be excluded that the society should also limit programs for future development, a circumstance which is related to a potential reduction in the future "available" resources.

A preliminary evaluation of these losses may be done on the basis of the same considerations which led to equation (1). It is clear that with nonobservance of the optimal service life, the outlays Z are increased in the indicated equation.

The magnitude of the losses, i.e., the difference between the outlays with an optimal service life for the equipment and the outlays for its actual service life will be

$$\Delta Z = \frac{c}{2} \frac{x^2}{t_{opt} + x} \tag{4}$$

where $x = t - t_{opt}$ is the deviation of the actual service life from the optimal period.

The losses ΔZ may be expressed using (2) as

$$\Delta Z = \frac{K_0}{t_{opt}} \cdot \frac{x^2}{t_{opt} + x} \tag{5}$$

Over the entire service life for the equipment these losses will be

$$\Delta Z_{tot} = K_0 \frac{x^2}{t_{opt}^2} \tag{6}$$

Consequently, the overall losses due to nonobservation of the optimal service life may be calculated starting from the optimal service period and the "regenerated" value of the basic stock. If, for example, the optimal service life is half the actual period, then the overall losses are equal to the summed expenditures in capital construction. This means that if timely updating is not carried out, not only are the resources not saved for it, but in addition, the society loses a sum equal to what would be required for facilitating the updating.

The problem boils down to how to determine the optimal service life, i.e., how to more adequately establish rates of technical progress. For

reference calculations (and perhaps, in the transition time to the present stage involving restructuring [perestroika] of the functioning mechanism for a socialist economy) it is possible to determine the optimal service life, starting, for example, from the service life of equipment in the industrially developed capitalist countries, where the criteria of economic efficiency are better taken into account in practice. Therefore, the actual service life there will clearly be closer to the optimal value, than in the socialist countries. But, no matter what the approach, increased care will be necessary. Nevertheless, considering the difficulties related with determining rates of technological progress and the cost of reproducing capital stock, a comparison of the service life of basic stock in the socialist countries with the service life of equipment in the developed capitalist countries will, in all probability, be one important criterion for evaluating those losses which the national economy incurs during a "departure" from the optimum.

But optimal service lives may also be established directly, starting from equation (2). But the problem is how to concretely define the magnitude of the parameter c, i.e., how to determine the annual increase in losses as a result of obsolescence? There are several opinions apropos of this. Some researchers consider scientific progress to be something so difficult to foresee, that it is impossible to predict. Though a determination of the rates of scientific-technical progress, or more accurately, how scientific-technical progress is reflected in the development of the technical-economic parameters of a new technology, is a difficult problem, its solution should not be shied away from, because it determines the reproduction of basic stock (if in the process of reproduction, not only the physical deterioration but also the obsolescence is considered). In practice, it is necessary in one way or another to do forecasting and provide an estimation of scientific-technical progress. For example, during an estimation of the efficiency of capital investment it is necessary to determine the rates of scientific-technical progress, in relation to the "generation" of so-called economic longevity, and in addition, the overall efficiency of the "regenerative action" contains within itself an estimation of the rates of scientific-technical progress.

The parameter c may be determined by dividing it into partial elements, such as total wages, expenditures for fuel and energy, raw materials, goods, etc. These partial elements will be determined either by a commission of experts, or on the basis of an analysis of statistical data.

Formula (2) may be generalized for more complex cases. For example: How does the optimal service life of equipment change if the volume of production in it (over time) changes, and it already constitutes not V_1 but V_2? We will obtain the answer by minimizing the relative expenditures:

$$\min_t Z' = \frac{K_0}{t_1 V_1 + V_2 (t - t_1)} + \frac{\int_0^{t_1} (S_0 + ct') V_1 dt' + \int_{t_1}^{t} (S_0 + ct') V_2 dt'}{t_1 V_1 + V_2 (t - t_1)} \qquad (7)$$

We obtain a result (for $t_{opt} > t_1$) in the form

$$t_{opt} = -t_1 \left(\frac{V_1}{V^2} - 1\right) \pm \sqrt{t_1^3\left(\frac{V_1}{V_2} - 1\right)^2 + \frac{2K_0}{V_2\frac{c}{V_1}} + \frac{t_1^2}{2}\left(\frac{V_1}{V_2} - 1\right)} \tag{8}$$

The answer is quite complex. But if over the course of the service life of the equipment it is operated less than its productive power allows, then the result obtained will be more simple:

$$t_{opt} = \sqrt{\frac{2K_0}{c}\,\frac{V_1}{V_2}} \tag{9}$$

Consequently, with a reduction in the use of basic stock, their optimal service life is formally prolonged. However, the efficiency of production is simultaneously reduced, which in this case may be ascertained by comparing the magnitude of expenditures (Z), with the optimal service life in the given case and when the volume of production was not reduced. Naturally, such a prolonged optimal service life is caused by operating equipment in a less "efficient" environment. Let us say that certain equipment is transferred to another branch, enterprise, shop, school repair shop, i.e., to where its lower (in terms of time) utilization is generally accepted and normal.

Formula (2) may be generalized, for example, for the case where in the course of operating the equipment, the parameter c is changed over time (t_1) from a magnitude c_1 up to a magnitude c_2 (by changes in the rate of technical progress):

$$t_{opt} = \sqrt{\frac{2K_0 - \frac{t_1^2}{c}(c_1 - c_2)}{c}} \tag{10}$$

Hence, with an increase in the rates of technical progress, the optimal service life is reduced.

In this manner it is possible to derive a formula for the case where over time (t_1), the technical level changes unevenly (for example, on the basis of the widescale implementation of a substantially important discovery or invention):

$$t_{opt} = \sqrt{\frac{2K_0 - A \cdot t_1}{c}} \tag{11}$$

where A is the magnitude of the jump (i.e., the magnitude which indicates the increase in losses as a result of the indicated change).

The considerations indicated above may be used primarily at the level of the national economy as a whole or the individual branches (and subbranches), which allows for consideration of changes in the extent of "liquidation" of basic stocks and their replacement, and in the service lives and capital investment for updating eliminated basic stocks.

There is still one further note. Because in specified optimal moment for updating exists, a certain efficiency in investment actions should also exist. If updating is postponed, then the overall efficiency of updating is reduced. A high efficiency of new investment actions is facilitated by the nonobservation of the optimal period of updating. Consequently, a high efficiency of investment "regenerative" actions included in the plan may testify to a "neglect" of the situation.

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TRAINING OF PRODUCTION PERSONNEL FOR FMS

81442826b Moscow MASHINOSTROITEL in Russian No 2, Feb 88 pp 36-38

[Article by Candidate by Technical Sciences V.G. Lepikhov and Engineer M.V. Lepikhov; passages within slantlines are rendered in Latin alphabet in the original]

[Text] The problem of training and retraining of high-skilled personnel has become very acute under the current conditions of large-scale implementation of flexible manufacturing systems (FMS).

FMS structure and the complexity of individual elements thereof pose more stringent requirements to professional and personal characteristics of workers serving these systems: they must possess versatile technical knowledge, be able to think creatively and take initiative; have a strong feeling of responsibility for functioning of the subsystem they were entrusted to operate, as each malfunction can mean substantial economic losses for the labor collective; and be ready to master new types of products, technology, equipment, profession and workplace.

The increasing economic role of workers responsible for FMS serviceability is demonstrated by the fact that 1 hour of downtime of an individual CNC machine tool costs R30, whereas 1 hour of downtime of a CNC in an FMS can cost as much as R150.

During the 12th Five-Year Plan, the demand for high-skilled workforce, especially in new professions, increases. Thus, according to specialists' calculations, Minstankoprom SSSR [USSR Ministry of Machine Tool and Tool Building Industry] will have to train 1,700 additional setup mechanics and operators, and Minpribor SSSR [USSR Ministry of Instrument Making, Automation Equipment and Control Systems] will have to train over 8,700 more workers for robot setup and service. Under these circumstances, the role and responsibilities of the system of vocational and technical education in training workers in robotics and FMS increase.

Thirty-five vocational education schools (PTU) of Leningrad and Leningrad oblast were the first ones to respond to this social request. In the early 1980's, they set up training of skilled workers of the new profile. This called for restructuring of the educational process, complete renewal of their material educational base and training of production instructors and

teachers in accordance with the new goals. Thus, at PTU-83 a robotized production department has been commissioned; at PTU-122 the latest generation computers and microprocessors have been installed, and in TU-38 [technical school] a training robotized line has been commissioned. The PTU-83 robotized production department manufactures several items included in the base enterprise plan. In 1984 alone, Leningrad and Leningrad oblast PTU graduated 2,500 FMS specialists.

In the system of vocational and technical education, they have developed and implemented programs for training CNC machine tool operators and setup mechanics of CNC machine tools and manipulators (these two professions, as well as the profession of a hammer, press, and manipulator operator, have been added to the Unified Tariff and Classification Manual). Tariff-classification job descriptions contain stringent requirements to 5th and 6th-class setup mechanics of CNC machine tools and manipulators. In particular, they must have secondary specialized education. A 5th-class setup mechanic must be able to setup robots and equipment of modular systems of the "Machine tool (machine)-robot" type and FAP [flexible automated production] lines. Job descriptions for the 6th-class setup mechanic include setup and adjustment of PR [not further identified] and CNC equipment that are part of FAP. A setup mechanic must perform complex technical computations required for setting up machine tools and machining complexes.

In some countries professionals think it is impossible to solve the personnel problem in the area of new worker's professions without implementing a State policy. In our country, an Integrated Program of Providing Training Retraining and Improving Professional Qualification of Professionals With Higher and Secondary Specialized Education and Skilled Workers in the Area of Development, Manufacturing, Operation and Maintenance of Robotic Complex, Flexible Manufacturing Systems and CAD Systems has been developed for the 12th Five-Year Plan.

In 1983 the French government identified priority directions in its activity aimed at the development of additional programs of professional training of high-skilled workers. In particular, in 1984 a substantial amount of money was allocated for expanding training of specialists in robotic and electrical equipment. In Great Britain, a national program "/Alveg/" is in operation. It provides for the creation of special centers for improving professional skills, retraining and training of FAP specialists. In the United States, a research center for training professionals in robotics and automated systems has been created under the auspices of the Department of Education. In Japan, an "International Center of Robotics and Automated Manufacturing Technology" (/IRORA/) has been created in 1985. It functions as a scientific research and experimental design base and an organization that trains skilled specialists in robotics.

In some countries (Bulgaria, FRG, United States, etc.), training robots are manufactured, at the price which is several times lower than that of production robots. Thus, in the United States 22 companies manufacture 49 types of training robots. They are characterized by low price ($3,000 to

$4,000) and low weight (under 30 kg); they are controlled from personal computers and are safe. According to American professionals, a class for 25 students, equipped with /XR/-1 robots and necessary ancillary equipment, costs around $40,000.

Unfortunately, in our country the material and laboratory base for training FAP specialists under the system of vocational and secondary specialized education has so far been lagging behind the state-of-the-art. One of the main reasons for this is that nobody manufactures training robots and models of individual FMS components and elements; and simulators for developing skills for control of machine tools and other equipment, as well as electrically powered stands that facilitate accelerated formation of students' professional skills, are practically nonexistent. The main difficulties are that vocational and secondary specialized education schools experience shortage of skilled teachers and training instructors that have sufficient knowledge of and experience in the development, operation and maintenance of FAP elements. The existing remuneration system does not attract these professionals from the industry.

An FMS equipment setup mechanic, being the main figure in FAP, cannot solve all problems of FMS setup, support and maintenance. Under current conditions, one should talk of a "working personnel module" for FMS, which must include operators and setup mechanics of automated material handling and warehousing subsystems, computer operators, operators of instrumentation devices, maintenance and repair mechanics, etc. It should be noted that the system of vocational and secondary specialized education practically does not train specialists in the above professions who can service FMS, which adversely affects the implementation of newly commissioned FMS.

Lately, a large number of personnel departments at enterprises have been talking of the need to train high-skilled workers of the secondary and even higher specialized direction. As a positive step, one should mention the introduction in our country, effective 07-01-87, of such specialties for professionals with secondary specialized education as manufacturing of industrial robots; operation and maintenance of industrial robots; CAD hardware; and programming for automated systems.

Thus, secondary specialized educational institutions (technical schools) are getting involved into the problem of training and graduating high-skilled workforce for FMS. In the United States, a large number of community colleges train specialists with secondary technical education in robotics and production automation. In 1985, 5,000 students were trained in these programs. During the educational process, main attention is paid to acquiring practical skills in troubleshooting and programming.

Practice of enterprises demonstrates that training and improvement of professional skills at the enterprise is a widely acclaimed form of training. For instance, in Japan the main portion of work on professional training of workers is conducted mostly at the enterprises, whereas in Western countries it is done by specialized organizations. According to the Japanese Ministry of Foreign Trade and Industry, 80 percent of

enterprises, including 89 percent of large companies, have their own professional training systems.

Lately, training of high-skilled workers with participation of enterprises that manufacture new equipment is becoming ever more important. An example can be set by the way it is done at PO [production association] "Leningradskiy elektromekhanicheskiy zavod imeni 60-letiya SSSR." Here, based on a contract with the base SGPTU-130 [special city vocational and secondary specialized education school], setup mechanics and operators of CNC machine tools and robots-manipulators are trained, and workers from other enterprises are taught, at courses and in cooperative education programs, the service and maintenance of CNC systems for control of machine tools and robots made at the association. At a number of machine tool building enterprises this work is organized in the same way. There, training of workers for service and maintenance of robotic and CNC equipment is conducted at specific-purpose courses organized at special enterprises that manufacture this equipment. In this regard, it merits notion that, for instance, ENIIMS [Experimental Scientific Research Institute of Metal Cutting Machine Tools] experience demonstrates that young people who have returned home from the Army are the ones who are the best prepared for training as setup mechanics of CNC equipment. Apparently, the fact that their nervous systems turn out to be the most capable of overcoming accompanying psychological stresses shows.

Training of setup mechanics of FMS equipment at specialized courses of industry institutes for improving professional qualification (IPC) has been widely spread now in certain machine building subindustries. This is the way training of the 6th-class setup mechanics of CNC machine tools and manipulators is organized at the Yaroslavl Branch of Moscow IPC of the Ministry of Automotive Industry. There, only people with higher or secondary specialized education are enrolled in 10-month courses.

Analysis of the status of training and retraining of high-skilled personnel demonstrates that this problem is in the process of formation. At present, only a combination of all existing forms of workers' education and retraining can provide the solution of complicated personnel problems and facilitate achievement of a higher level of labor productivity.

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IMPROVEMENT AND DEVELOPMENT OF PRODUCTION STRUCTURE FOR ARTICLES AND BLANKS BY FORGING AND DIE FORGING IN MACHINE BUILDING

18610149 Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 1, Jan 88, p 4

[Article by Yu.S. Radyuchenko]

[Text] In the final stage of metal item production in machine building, the ferrous metal waste amounts to more than 20 million rubles a year. More than 40 percent of the waste is in the form of shavings. About 5 million tons of shavings are produced in processing forged and stamped blanks. The relatively low rates of metal utilization are explained by the increasing design and technological complexity of items and parts and by the irrational structure and organization of production in machine building. Only through the improvement of production structure and organization, the growth of specialization, and an increase in shift-work use of equipment is it possible to achieve 20-40 percent reduction in metal expenditure (1).

The specialization of press forging on an intra- and interindustry basis in the manufacture, for example, of components of a class of hardware or fittings is insufficient. This materially restrains the wide use of progressive technology and causes big wastes of metal in shavings. Moreover, 86 out of every 100 machine building enterprises manufacture forged products for their own needs, and 76 manufacture stamped blanks (2 and 3). The growth of specialization creates prerequisites for the introduction of progressive technical solutions which ensure savings in metal and a significant reduction of labor costs. With the growth in production volume of forged products (forged and stamped), the technical and economic figures are improved. The mean value of the metal utilization coefficient (KIM) in machine building and metal working (taking into account the reprocessing of metal powders) amounted to about 0.650 in 1980. As applied to the different methods of metal processing, this indicator has the values: 0.465 for forging, 0.540 for hot stamping, 0.680 for sheet-metal stamping, 0.720 for cold forging, and 0.770 for compaction of metal powders.

In evaluating the KIM, data were used from nine branches of the machine-building sector (4) and from seven non-machine-building branches with widespread metal working. The change in the share of product manufacture

by various methods of forging and die forging is presented in the table. It follows from the table that the manufacture of products by forging and hot stamping is decreasing, while the manufacture of articles by cold forging, as well as by extrusion of metal powders and plastics, is rising. The share of forged products produced by forging from ingots is growing in comparison with the share produced by forging from rolled metal, which is in accord with the current trends in structural improvement of press forging (1,2).

Change in Production Share (percent) by Various Manufacturing Methods

Manufacturing method	1960	1970	1980	1985
Forging including:	30.83	27.40	23.24	22.28
Forging from rolled stock	20.30	17.00	13.92	12.79
Forging from ingots	10.53	10.40	9.32	9.49
Hot stamping	46.56	44.00	42.08	41.14
Cold forging	6.11	11.00	15.01	16.14
Bending	16.49	14.10	14.39	13.42
From metal powders	0.01	0.09	0.21	0.38
From plastics	--	3.41	5.07	6.64
Total	100	100	100	100

Progressive technology will receive primary development in the future. Note the rapid growth in output of articles by cold forging as well as by extrusion from metal powders and plastics. The main contribution to the development of technology is supplied by mastering forging on automated systems and using continuous casting plants, radial reduction on new machines, hot stamping with sectional dies, electroforging on automatic machines, cold and semiheated extruding, tapered forge-rolling, spherical stamping, stamping from castings, and other effective processes. The widespread introduction of technological processes for the manufacture of articles out of metal powders and plastics is expected. This will ensure economical expenditure of material and reduction of labor costs on the after treatment of the items.

The technical reequipping of press forging in the next few years must be directed towards using the productive capacity of automated systems adopted in the 10th and 11th Five Year Plans for forging with numerical programmed control presses for cold extrusion, continuous steel casting plants, the range of double-acting hot stamping presses for crankshafts, electroforging, and radial reducing machines of new design. Systems with numerical programmed computer (including robotized) forge-and-pressing processing centers and flexible automatic modules of various functional designs are being created. It is planned to increase production of blanks by the precise cutting of bare rolled stock, cold and semihot forging, progressive hot stamping, and tapered rolling.

It is assumed that the application of new processes and machines will ensure metal savings of enterprises of Minavtoprom, Minselkhozmash, and Mintyazhmash [Ministries of the Automobile Industry, Tractor and Agricultural Machine Building, and Heavy and Transport Machine Building]. The metal savings by these branches amounts to more than 83 percent of the planned overall savings of metal by forging and hot stamping of the entire machine building sector. As a whole in the nine main machine building ministries, the mastery of metal saving processes (including the reprocessing of metal powders) will make it possible to save in 1990 alone up to 600,000 tons of metal in comparison with 1985. Moreover, the turning of metal into shavings during subsequent processing is decreased by 480,000 tons; the expenditure of electricity is cut by 500 million kw; and savings from the decrease of labor costs in the cutting of metal into chips amounts to about 180 million rubles. The share of savings due to the development of production and improvement of the various processes are: forging: 12.7 percent; hot stamping: 66.5 percent; cold forging: 7.5 percent; reprocessing of metal powders: 13.3 percent. The increase in production volume of articles from plastics at enterprises of the machine building sector in 1990 by 150,000 tons compared to 1985 will make it possible to save about 400,000 tons in the last year of the 12th Five-Year Plan. Thus, the main savings of metal, power, and labor costs will be supplied through the increase in output volume of articles made from plastics, the improvement and development of hot stamping technology, and technical reequipping, using progressive types of press forging equipment.

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LABOR SAVINGS IN MACHINE BUILDING INDUSTRY

81442826g Moscow MASHINOSTROITEL in Russian No 3, Mar 88 pp 29-30

[Article by Engineer G.A. Klimov under the "Economics, Efficiency, Quality" rubric]

[Text] Implementation of new technology remains the main lever in improving the efficiency of production. The highest success is achieved when technical, organizational and economic measures are implemented as a package. However, expenses for freeing up one worker due to improved organization of work are, as a rule, much lower than when implementing new technology. Reducing the amount of manual labor is one of the main reserves that do not require huge expenditures.

At a large number of inspected enterprises of the former Minzhivmash [USSR Ministry of Machine Building for Animal Husbandry and Fodder Production], the share of manual labor in total labor cost exceeds 25 percent, and at some of them it exceeds 50 percent.

The structural composition and characteristics of labor cost at these enterprises are shown in the table. The share of manual labor is especially high in assembly, which has the second highest labor cost after machining. All in all, the share of manual labor in assembly operations at inspected enterprises is 58.93 percent. There are enterprises where assembly is 100 percent manual. There is a large share of manual labor in packaging (72.74 percent) and woodworking (49.42 percent). Mechanization of welding is insufficient: the share of manual labor is 22.94 percent. the welding process per se is mechanized, but cleaning, straightening, assembly of weldments and other operations are mostly done manually. At some enterprises the share of manual labor in welding exceeds 50 percent.

The share of manual labor is high in ancillary operations, such as setup, clamping and moving, and in operations considered to be mechanized, such as machining, press-forging and stamping. According to data derived in the process of inspecting technically substantiated standards (TSS), only about 40 percent of these operations have been mechanized.

Studies of labor costs in machining have demonstrated that increasing the level of mechanization of parts clamping from 40 to 82 percent will make it possible to reduce labor content of part setup and removal or to free up over 120 machine tool operators.

Process	Share of labor cost in overall labor content of product manufacturing (percent)	Share of manual labor (percent)	Share of TSS (percent)
Machining	27.02	1.37	79.85
Assembly	21.82	58.93	64.05
Welding and thermal cutting	17.52	22.94	71.46
Cold stamping and blanking	7.82	8.24	70.28
Protective coating	5.95	25.81	71.95
Press-forging	5.38	8.69	75.95
Casting	5.07	28.01	75.46
Packaging	2.1	72.74	63.3
Heat treatment	1.97	19.64	78.77
Woodworking	1.66	49.42	71.94
Other	3.69	41.55	70.04
Total	100.00	25.58	72.75

As a rule, at manual operations the work process is poorly organized, and the level of time standard setting is low. All in all, at inspected enterprises the share of TSS is 64 percent in assembly operations and 63.3 percent in packaging. Time standards at these operations exceed calculated standards by 100 percent and more.

Analysis of labor content of products demonstrates that the share of practical-statistical standards at enterprises is high. For the main nomenclature alone their share is about 30 percent, over 50 percent at some enterprises. One of the reasons for this is that labor content of newly introduced products is mainly determined from previous experience, and in most cases this does not cover necessary labor expenses. When technical and organizational measures aimed at increasing labor productivity are implemented, the then-effective standards are not revised in a timely manner. Just like the practical-statistical standards, they do not correspond anymore to current conditions at the enterprise, are being considerably exceeded and do not create incentive for increasing labor productivity.

Revision of obsolete and understated standards and implementation of new, technical substantiated ones are among the main factors facilitating reduction of labor content and efficient means for utilization of production reserves in order to further improve its efficiency.

Technically substantiated labor content standards must be progressive. They must be determined based on a rational technological process and industrial engineering requirements. At a large number of enterprises the level of TSS is not up to these requirements. Often, workers exceed

standards by 50 percent and more. Studies conducted by Rostov NIITM [Scientific Research Institute of Machine Building Technology] have demonstrated that only one out of six standards is exceeded by 50 percent due to high professional skills of workers. Usually, standards are exceeded due to shortcomings in the technological process, understated equipment operating modes specified in process sheets and discrepancies between the established standards and actual organizational and technical production conditions.

By increasing the role of manufacturing engineers in organization of work and setting work standards and by having them provide integrated solutions to problems of organizing the work process by calculating and implementing progressive standards, substantial labor savings can be realized.

At enterprises, it is necessary to revise time standards in a timely manner, when organizational and technical measures that result in increased labor productivity are implemented, and bring the then-effective time standards in compliance with the achieved level of production. This work must be based on calendar plans of standard revision. A creatively developed plan makes it possible to revise standards in a timely manner after organizational and technical measures have been implemented, and justifiably plan reduction in labor content of product manufacturing. This work only brings desirable results if it is done by personnel of industrial engineering departments in cooperation with manufacturing engineers, accountants, foremen and progressive workers.

It is important that the management and trade union committee systematically check the then-effective standards. This checking should be conducted during workstation certification. This will make it possible to timely identify standards that have been established by mistake and those that are obsolete.

Determination of calculated (design) labor content of each product is an important reserve in reducing labor cost.

Calculated standards are TSS of production that has been mastered, when appropriate organizational and technical conditions have been provided and progressive forms of organization of work have been implemented. This is why achieving the calculated labor content induces improved working conditions, increased level of mechanization and higher labor productivity. But in order to create such reserve, certain conditions must be met.

First of all, it is necessary to clearly develop technological processes of individual operations with comprehensive and substantiated information necessary for setting time standards (operating parameters, routings, quality control etc.). Second of all, it is necessary to organize at enterprises appropriate record keeping and control of changes in design time standards, which will make it possible to correct and control TSS in a timely manner. Thirdly, it is necessary to have professional and responsible inspection of technological processes and TSS computations in industry organizations. Production implementation of design standards since the moment of new product introduction, using add-on payment

coefficients during this period, will make it possible to substantially reduce labor content and increase labor productivity.

Better utilization of the available production time is a substantial reserve for saving labor resources. As photographs of working days have demonstrated, losses of production time due to material shortages, organizational and technological reasons and worker's fault are as high as 14 percent. In 1985, losses caused by deviations from established technological processes and rework of rejects in the industry were equal to about 4 million manhours, or to production time of more than 2,000 workers.

By conducting scheduled time and motion studies, implementing measures aimed at elimination of production time losses and deviations from technological processes and by reducing the allowed number of rejects, it will be possible to free up substantial labor reserves.

Virtually all machine building enterprises have reserves for labor savings. Systematic implementation thereof is in line with current requirements of intensification of production.

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FORECASTING AND IMPROVEMENT OF PLANNING IN MACHINE BUILDING INDUSTRY

81442826h Moscow MASHINOSTROITEL in Russian No 3, Mar 88 pp 30-31

[Article by Candidate of Economical Sciences M.P. Kozlovskaya]

[Text] Improvement of planning calls for increasing scientific significance of those stages of planning whereat the national economy status and development trends are analyzed and possible prospectives therefor are forecast. This is why a plan-directive should be developed based on scientific studies of long-term development, i.e., based on forecasting. In our country, forecasting is becoming the most important element of the State S&T policy, and since 1968 it has been an integral part of the unified process of planning of the national economy.

In spite of this, machine building subindustries, which are playing the predominant role in restructuring of the national economy, have not been paying adequate attention to problems of economic forecasting. They only develop economic forecasts of equipment demand, based on anticipated production volumes and standards for machinery demand by customer industries, and compute economic efficiency of forecast machinery models. They also compile economic forecasts of demand for material resources and development of the industry production potential and location.

At present, machinery forecasting is only based on achieving specified values of technical parameters that provide for increased capacity, operating and transport speeds etc. In doing so, no goals are set for achieving certain economic parameters. As a result, new machines do not always provide return on investment made into the development thereof, whereas their production rate is lower than required by the pace of industry development and directive indices. Economic justification of technology development forecasts consists of calculations of economic efficiency of machines under development, while machine parameters in the forecasts do not orient one toward achieving a certain level of economic indices and realizing the maximum possible savings.

Development of the country's economy is based on increasing the productivity of social labor, which is mainly achieved as a result of increased productivity of machines. Taking this relation into consideration, technical and economic parameters of new machinery must ensure the planned productivity gain during the period under consideration.

The main objective of the development of the machine building industry is the maximum possible satisfaction of the demand of customer industries. Therefore, the fleet of machines to be developed during the forecasted period must fully ensure that the customer is able to accomplish the planned amount of work, taking into account technology forecasts. Development of technical and economic parameter of forecasted machinery must be subordinate to the goal, and improvement in these parameters must correspond to the increase in the amount of work by the customer, prospective technology, directive increase in labor productivity and the world level of technical development.

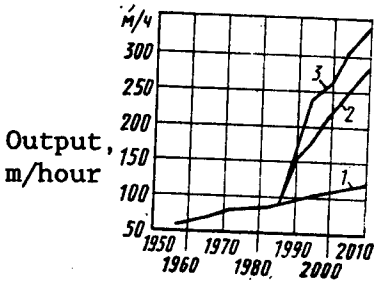
For a long period of time, factors of extensive development had been playing an important role in our country's economy, whereas production expansion was accomplished by increasing the amount of resources that were utilized (raw and production materials and workforce), and increasing capacity based on additional capital investment. At present, these sources cannot be used at the same rate as before. It is therefore very important to improve the efficiency of workforce utilization, eliminate hard manual labor and save material resources.

Under the current conditions, the limits of economic feasibility of further increasing the share of expenditures for expansion of production assets are very narrow. Due to this fact, another major task is set: more efficient utilization should only be brought up in cases when all other possibilities for realizing the required increase in production output by finding and utilizing internal reserves of the industry have been exhausted. One should therefore strive that newly developed machines have technical and economic indices that would ensure that the customer is able to fulfill the planned amount of work without expanding production capacity and without additional capital investment.

Under the conditions of restructuring of the national economy and production intensification, thorough substantiation of economic feasibility of parameters of new equipment must become an important goal of industry forecasts of new technology. Not only must the forecasted equipment technically surpass machines it replaces and be at par with the best foreign models, but, when used, it also must bring the maximum possible savings to the national economy. An S&T forecast must include not just forecasted machine models with a certain set of parameters, but machine models with economically feasible technical and economic parameters, with the maximum possible return to the national economy. Therefore, planning in machine building subindustries at the current stage must be improved first of all by implementing forecasting of technical and economic indices of promising machines.

In our opinion, forecasting must have a normative-research character, with the normative component prevailing. According to the established tradition, forecasting of technological developments is mainly research in character, i.e., a so-called search forecast is developed, which consists of determining conceivable conditions of the object of forecasting in the future as a result of inertial development, without taking into

consideration specific-purpose management actions. During the restructuring of the national economy, when a radical leap in the development of all sectors of the national economy must be made, a normative forecast must replace a research one. Its essence is to determine conceivable ways of and the timeframe for achieving conditions of the object adopted as development objectives. In this situation, a research forecast can only perform ancillary functions and show what the status of the object of forecasting would be if current trends in its development remain the same.



Results of studies conducted in the irrigation machine building subindustry demonstrate that parameters of a normative forecast are significantly different than those of the research one. For instance, we shall examine the graph of increase of technical output of ditch drain-tube layers for the drainage zone for the period up to the year 2010. Curve 1 was plotted by extrapolation of the research forecast data, curve 2 by using the method of expert assessments based on the above forecast, and curve 3 was plotted according to the normative forecast data. One can see from the graph that at the end of the period the value of the index derived from the normative forecast is almost three times higher than in the case of the research forecast. This difference is due to the need to increase the technical level of drainage machines to the level of foreign equipment. Of course, developers of new, more productive machines will have to overcome considerable difficulties in production expansion and reveal necessary reserves in order to reach the normative level of these parameters during the forecast period.

When developing forecasted technical and economic equipment parameters, one should take into account, first of all, customers' needs, production volumes and the directive increase in productivity; second of all, limitations equipment manufacturers experience in production capacity and material and labor resources; and third of all, the need to realize maximum possible savings for the national economy. A normative forecast must become the starting point in the subsequent search for reserves, choosing specific directions in equipment development and determining technical and economic parameters thereof. The use of a normative forecast will help meet the tasks set forth for machine builders by the Party and government.

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ADJUSTABLE ROBOTIC COMPLEX

814428262c Moscow MASHINOSTROITEL in Russian No 3, Mar 88 p 13

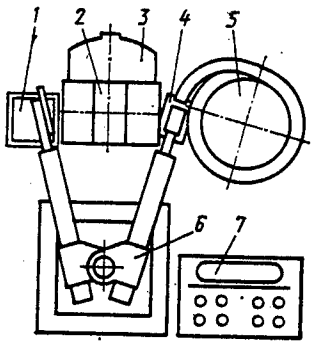
[Article by Engineer Yu.I. Kalinichenko]

[Text] A robotic complex (RC) for stamping angle-shaped parts that can be adjusted for different leg lengths and made from various width single-piece blanks has been developed. It consists of a vibrating bin, model RF2-2M industrial robot (IR) and model KD2118 6.3 t crank press. An adjustable bending die that has a rather simple design (Certificate of authorship No 1282940) is installed in the press. Die gibs carry the main stop with a spring-loaded pusher and an additional gate stop installed in the same plane with the front edge of the bending punch above single-piece blanks fed one-at-a-time into the die.

The complex operates on commands from programmable controller 7. A blank from vibrating bin 5 arrives into infeed through 4 and via an electromagnetic transducer U511 shuts off the vibrating bin. The right arm of industrial robot 6 with an electromagnetic gripper turns toward the infeed trough, pulls the blank and takes it away, as the robot turns along an arc with its tangent perpendicular to the direction of blank feed from the vibrating bin. At the same time, the left IR arm equipped with a scraper pushes stamped parts off lower die-set plate 2 of press 3 into container 1. The right IR arm, after bringing a blank into the trough and after the electromagnetic gripper has been shut off, pushes a row of previously delivered blanks until the first blank touches the main stop.

After the blank feed force is removed, the spring-loaded pusher moves the row of blanks in the opposite direction, until the opposite end of the first blank touches the gate stop. The first blank is being bent. The IR gripper returns to its initial position. By this moment the next blank has arrived from the vibrating bin into the infeed trough, and the stamped part is pushed off the die onto the lower die-set plate when the row of blanks is advanced. The cycle is repeated.

The die makes it possible to make angles from blanks that have various lengths and widths. It is set up according to blank length right there in the press by moving gibs on the die. The set up does not have to be changed when blank width changes, as it is only necessary to increase or reduce the turn angle of the robot and put proper size blanks into the vibrating bin.



Compared to the use of special dies and taking into account the set-up time for various size blanks, RC productivity at least doubles. Besides, the accuracy of parts positioning increases, and quality of stampings improves.

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HAND BAND GRINDER

81442826k Moscow MASHINOSTROITEL in Russian No 3, Mar 88 p 39

[Article by Engineer B.N. Khatov]

[Text] Hand band grinders are used for surface cleaning when it is difficult to use mechanized grinding. However, the absence of a common standard for the design of such grinders hinders the spreading of this progressive method of grinding in the domestic industry.

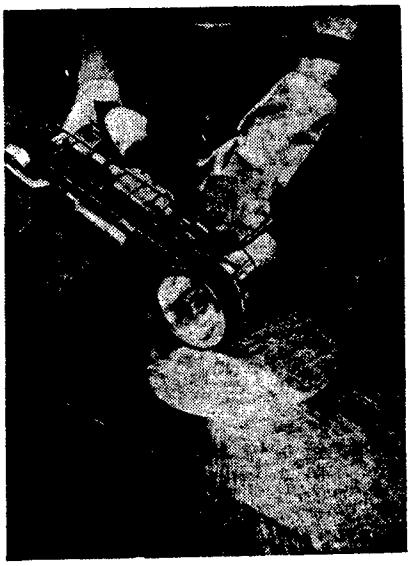

Figure 1

A hand band grinder based on the air motor of a series-produced facer model IP-2203 has been developed (Figure 1). On the bracket of air motor 1 (Figure 2) support 4 is installed. The support carries bracket 6 with band tensioning air cylinder 7. Fork 10 with banana tension roller 11 is mounted on air cylinder rod 8. Abrasive band 2 is installed over the tension roller and drive (contact) roller 3. The latter presses the band against the machined surface. Compressed air is fed to the air cylinder via hose 12 connected to the main air line. Compression spring 5 is provided for pretensioning of the abrasive band when the grinder is turned off. Band position on the contact roller is adjusted by turning the banana

roller about the rod axis with the help of screw 13. The grinder is held in working position with the help of handle 9; the position of the handle on support 4 is adjusted depending on the operator's size. The abrasive band guard is provided. Grinding is performed with abrasive bands LB 40 x 1,000, manufactured by the Zaporozhye Abrasive Combine imeni the 50th anniversary of the Soviet Ukraine.

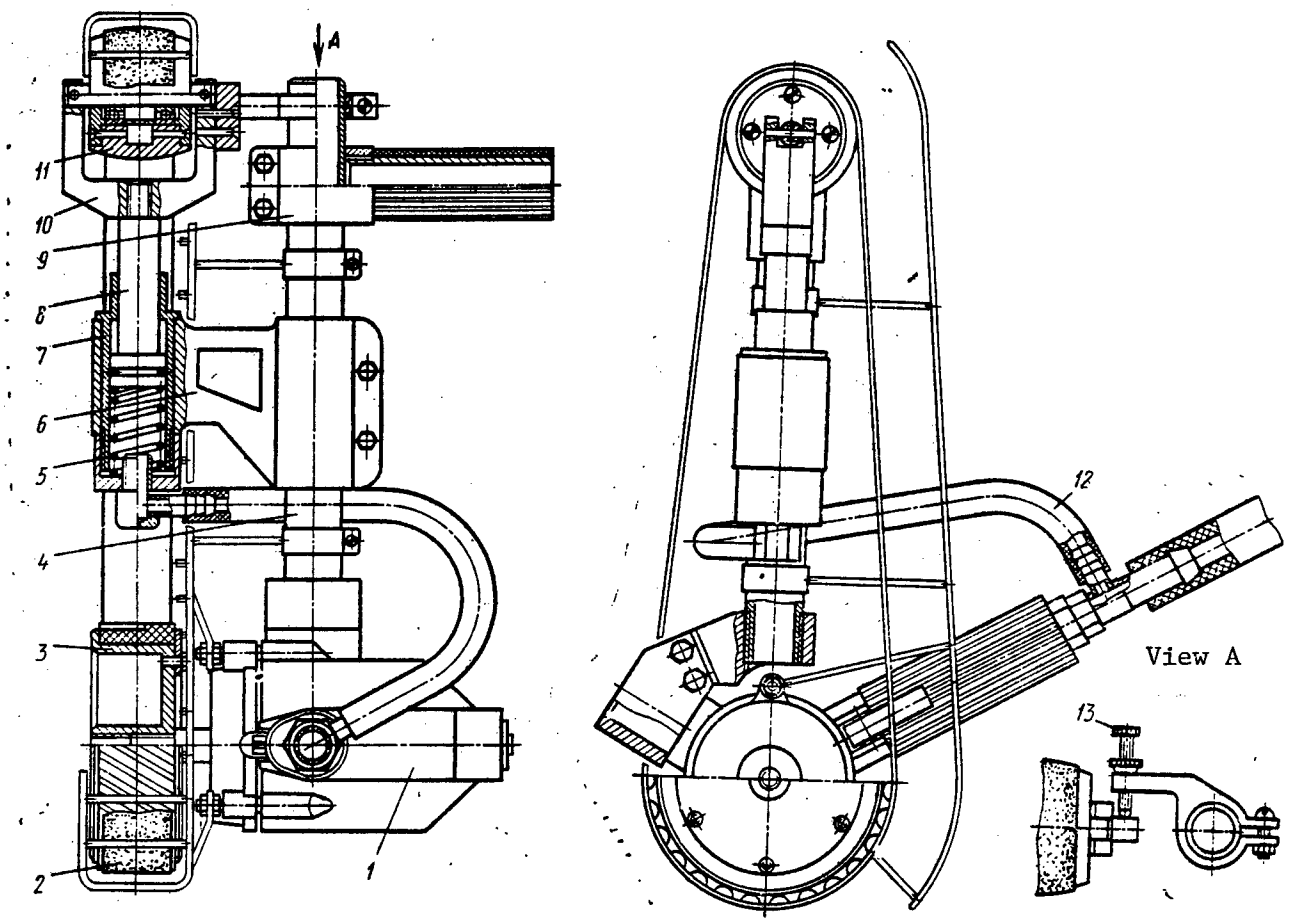

Figure 2

When band 14A40P is used, surface roughness Ra = 3.2-2.5 μm; when band 14A25P is used, surface roughness is 1.25-0.8 μm. When grinding corrosion-resistant steels, band longevity is between 40 and 60 minutes. Surface edges and small cylindrical parts can be ground using the free side of the abrasive band. In order to increase stability of the grinder when grinding large surfaces, an additional support roller can be installed on the free side of the air motor. Grinding speed is 30 m/s. Overall dimensions of the grinder are 230 x 320 x 450 mm, mass is 5.8 kg.

The band grinder has been implemented at several enterprises. It makes the work easier, increases productivity and improves the quality of machining. A rubber-coated contact roller completely eliminates transmission of vibration to the operator's hands. The grinder is simple in manufacturing and operation.

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METAL-SAVING TECHNOLOGY OF ASSEMBLING FIXED CONVEYOR JOINTS

81442826d Moscow MASHINOSTROITEL in Russian No 3, Mar 88 pp 23-24

[Article by Engineers V.I. Kushakov, M.Z. Gofman, G.V. Nikolayeva, and A.N. Brokhov]

[Text] Pulleys and first of all shaft-disk joints are among the most heavily loaded components of belt conveyors manufactured by enterprises of various machine building subindustries.

In existing designs of pulleys with outside bearing assemblies torque is transmitted from the shaft to the disk via key joints. This increases the labor content of shaft and disks manufacturing and assembly and calls for additional fitting operations with a large volume of manual labor involved. Besides, key joints call for thicker disk hubs and reduce fatigue strength and endurance of the shaft due to stress concentration in the weakened cross section.

Application methods of strength analysis of mating parts under various types of loading (rupture, shear, torsion), used in engineering practice, only take into account mechanical properties of materials within the elastic deformation limits, i.e., only according to Hooke's law. It has been determined experimentally that beyond the proportional limit mechanical properties of ductile materials increase, as hardening occurs. Heretofore, this feature of ductile materials (the majority of structural materials for machine parts are in this category) has not been taken into account in strength analysis of machine parts and interference joints.

At the Ukrainian Correspondence Polytechnic Institute imeni I.Z. Sokolov (Kharkov), a method for application strength analysis of interference joints has been developed.

Using this method, keyless shaft pulley disk joints of general-purpose belt conveyors with 650-1,200 mm wide belts were calculated and designed.

The material of the female part loaded beyond the proportional limit retains a specified safety margin even without key or pin connections and with a thinner hub. Due to elimination of stress concentration (keyways and keyseats, threaded holes, etc.), shaft endurance and fatigue strength increase.

d, MM	d_1, MM	ℓ, MM	Hub mass (kg)	Reduction of hub metal content (percent)
06	95	70	2.1	35
70	114	80	3.7	38
95	146	100	7.0	42
120	164	120	8.9	48
140	203	120	15.6	54
160	245	140	28.5	56
190	273	210	48.2	60

Labor content of manufacturing and assembly decreases, as does parts cost, and certain metal cutting equipment used for machining keyways and keyseats is freed up.

The Nikolayev Material Handling Machine Building Plant has started production of pulley of stationary belt conveyors with keyless shaft-disk joints. The plant uses metal-saving technologies of manufacturing mating parts, and induction-heat assembly.

Metal content of parts is reduced due to 40 to 50 percent lower disk hub thickness. The interference is increased, so that hub material in the joint is loaded beyond the proportional limit and strengthening occurs. In order to get parts fit with the design preload, induction-heat assembly is used. High-speed induction preheating of disks is performed in a special semiautomatic machine. Joints are assembled with a temporary clearance, retaining initial high quality of mounting surfaces and providing higher strength than press fit. Design safety margin of the joints was at least 4.5, with the permissible value of 2.5. It has been determined experimentally that actual safety margin was 1.5-1.6 times higher.

Figure 1 shows a lighter keyless design of the shaft joint with two pulley disks. The table gives nominal dimensions and mass of mating parts. The pulley hub hole is made to H8 tolerance, and shaft journals are made to H8 tolerance.

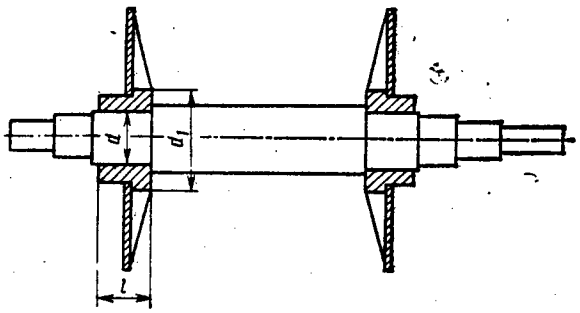

Figure 1

High-speed induction heating of disks 6 (Figure 2) is performed in a semiautomatic machine that consists of fixed C-shaped magnetic circuit 3, upper traveling core 1, two excitation windings (lower 5 and upper 2) and table 4 moved by an air cylinder. When the machine is equipped with a manipulator, it can work in a semiautomatic or manual mode. It also can work in an automatic mode and can be easily built in into flow-line assembly lines.

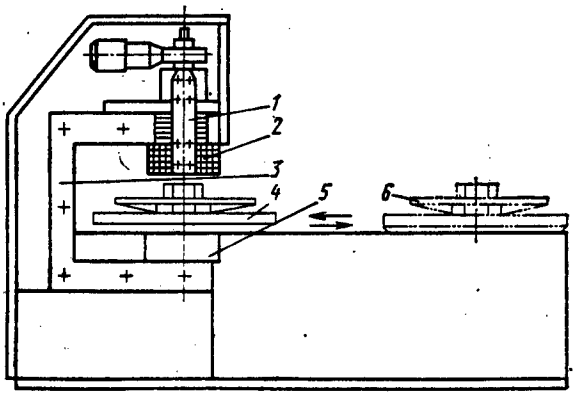

Figure 2

Elimination of key joints and simplification of assembly technology at the manufacturing plant reduced labor content of machining pulley disks by 20 percent and labor content of assembly with the shaft by 50 percent, with over 120 tons of metal saved annually.

Since the lighter design and the new technological process have been implemented, there have been no cases of pulley failure caused by loosening of or loss of strength in shaft-disk joints.

Annual savings due to the implementation of the semiautomatic machine and metal-saving technology exceeded R50,000.

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NEW STANDARD FOR METALCUTTING MACHINE TOOLS DISCUSSED

81442826e Moscow MASHINOSTROITEL in Russian No 3, Mar 88 p 26

[Article by L.I. Latynis: "New Standard"]

[Text] Industrial design of machine tools, machines and technological equipment has been one of the principal directions of activity of the Vilnius Branch of the All-Union Scientific Research Institute of Technical Aesthetics (VNIITE) for 20 years now. The Branch developments in this area have won wide public acclaim; they have been awarded a large number of prizes at international and domestic exhibitions and are protected by Industrial Sample Certificates of Authorship.

Based on the experience in industrial design of products of the machine tool building industry, the Vilnius Branch of VNIITE in cooperation with ENIMS [Experimental Scientific Research Institute of Metalcutting Machine Tools], VTsNIIOT [All-Union Central Scientific Research Institute of Labor Safety] and the Kolomna Machine Tool Building PO [production association] have developed an Industry Standard 2NO-8-1-86 "SSETE. Stanki metallorezhushchiye. Obshchiye trebovanya tekhnicheskoy estetiki i ergonomiki" [System of Standards of Technical Aesthetics and Ergonomics. Metalcutting Machine Tools. Technical Aesthetics and Ergonomics: General Requirements]. The standard has been introduced on 1 January 1987. It is aimed at improving the quality and competitiveness of domestic metalcutting machine tools. It must serve as guidelines for designers, industrial designers, and ergonomics specialists in the design and modernization of machine tools and in formulating specific requirements in regards to technical aesthetics and ergonomics.

The standard defines the outer structure of metalcutting machine tools as a visually organized shape of a system of structural elements that is interconnected with its functional contents and reflects the structure of activities of the operating, service and maintenance personnel. It also defines other concepts, such as a "Machining Zone," "Scale Factor" and "Proportions." Within the scope of the Standard, general technical aesthetics and ergonomics requirements to the outer structure of a machine tool have been developed, including requirements to its informativeness, rational design and composition integrity, and requirements to placement of controls, to information display devices (IDD) and to principles of control panel construction.

The standard presents two methods for creative search for the outer structure of machine tools. One is the method of geometric construction of the outer structure of a machine tool, based on the method of basic geometric points developed by A. Gamzin, an industrial designer at the Vilnius Branch of VNIITE. Another is a design method that uses a module-coordinate matrix. Its essence is organization of the outer structure of a machine tool in accordance with the chosen module and layout configuration that takes into account requirements of ergonomics. This method forms the basis for wide implementation of parts and components unification. Machine tools and equipment developed at the Vilnius Branch with the help of these methods are widely used in the national economy and have gained high professional acclaim.

Ergonomics requirements to metalcutting machine tools presented in the standard are mainly aimed at reducing psychophysiological stress of and the number of errors made by the personnel and at increasing labor productivity by justified placement of IDD and controls in control panels.

Appendices to the standard graphically depict zones of placement of IDD and controls, using a coordinate grid, and present principles for placement of IDD and controls in control panels depending on the number of machine tool components to be controlled.

Implementation of the standard will help improve the practice of machine tool design and make it possible to lay ground for a harmonious outer structure thereof as early as at the initial design stage, when the layout configuration is chosen.

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INDICES OF EQUIPMENT REPAIR COMPLEXITY

81442826f Moscow MASHINOSTROITEL in Russian No 3, Mar 88 pp 27-28

[Article by P.P. Susin and A.A. Osikov]

[Text] At enterprises of the heavy and transport machine building industry, existing equipment is being repaired and modernized, along with replacement of morally and physically obsolete equipment. In the process, the "Standard System of Remuneration of Workers Performing Equipment Repair and Maintenance" is used. The system induces material interest of the repair personnel in the end result of their work, as it makes it possible to considerably improve equipment utilization and reduce the downtime for scheduled and unscheduled repairs by more than 7 percent.

The system is based on the "Yedinaya sistema planovo-predupreditelnogo remonta i ratsionalnoy ekspluatatsii tekhnologicheskogo oborudovaniya mashinostroitelnyk predpriyatiy (YeSPPR)" [Unified System of Scheduled Preventive Repair and Rational Operation of Technological Equipment of Machine Building Enterprises] (Moscow, "Mashinostroyeniye," 1967). Its implementation involves scheduling repairs in time and the scope and periodicity of repair involves scheduling repairs in time and the scope and periodicity of repair work, based on repair work standards. The main standards are categories of repair complexity (equipment repair complexity), the structure and length of the repair cycle and the time between repairs, and time standards for repairs and maintenance per unit of equipment repair complexity (1 URC). Repair complexity is an arbitrary value of planned labor content of repair and maintenance of a specific type of equipment; it depends on design and technological features of the equipment. Specifications in equipment manuals are used as initial data for determining repair complexity. The structure of the repair cycle is a list and sequence of performance of repair work during the time between overhauls or between commissioning of the equipment and the first overhaul thereof. Time between repairs is the period of time between two consecutive scheduled repairs. The length of repair cycles and times between repairs are established for each equipment group depending on the type of equipment and operating conditions.

Time standards for equipment repairs and maintenance are used for calculating labor content, the required number of repair workers and the cost of repair.

The concept of repair complexity proposed in the YeSPPR gives a quantitative characteristic of equipment repair features and complexity of repair, and makes much simpler the planning of repair work, performing of technical and economic computations and determining the required number of workers, as well as necessary spare parts, materials and financial resources required for the repair.

At present, the normative system of remuneration of workers involved in equipment repair and maintenance is starting slipping behind its purpose, because its recommendations have become obsolete, whereas new equipment, such as CNC machine tools, robotic complexes and flexible manufacturing systems, call for a different approach to their repair and for engineering and technical personnel participation. Besides, equipment manufactured by machine tool building plants quite often does not have a repair complexity category assigned.

Table 1

Type of machine tool	Basic parameters mm	Category of repair complexity, URC according to:			
		YeSPPR (Moscow, "Mashinostroyeniye", 1967)	Improving System of Operation, Maintenance and Repair of Technological Equipment at Machine Building Enterprises (Moscow, ENIMS, 1979)	Tables of Repair Complexity of Metal- and Woodworking Equipment (Moscow, ENIMS, 1983)	Tables of Repair Complexity of Metal- and Woodworking Equipment (Moscow, ENIMS 1985)
Lathe model 16K20	D = 630 PMII-1400	—	R_M =12.5 $R_э$ = 9.5	R_M =12.0 $R_э$ = 9.0	R_M =12.0 $R_э$ = 9.0
Lathe model 1M63	D =630 PMII-1400	—	R_M =16.0 $R_э$ =11.0	—	R_M =12.5 $R_э$ =11.0
Vertical lathe model 1550	$D_д$ =4500	R_M = 74	—	R_M =110	R_M =116
Circular grinder model 3A130	$D_{о.д}$ =280	R_M = 9.5 $R_э$ =20.0	R_M = 9.5 $R_э$ =20.0	R_M =19.5 $R_э$ =16.0	R_M =19.5 $R_э$ =16.0
Horizontal boring machine model 2631	$D_ш$ =125	R_M =25.0	—	R_M =65.0	R_M = 65.0
Horizontal boring machine model 262D	$D_ш$ =110	R_M =20.0	—	R_M =18.5	R_M =18.5
Turret lathe model 1P365A	$D_{пр}$ =20	R_M =20.0 $R_э$ =12.0	R_M =21.0 $R_э$ = 9.5	R_M =16.0 $R_э$ =12.0	R_M =16.0 $R_э$ =12.0

Table 1 shows repair complexity of machine tools that is recommended by various sources of information and is currently in effect. Here, D is the maximum workpiece diameter; *РМЦ* is the maximum center distance; $D_п$, $D_{о.п}$, $D_ш$ and $D_{пр}$ the chuck plate, workpiece, spindle and rod diameters, respectively; $R_м$ and $R_э$ are categories of repair complexity of the mechanical and electrical part of equipment, respectively.

One can see from Table 1 that vast differences in categories of repair complexity do not help improve planning and putting in order repair departments.

We shall now examine the effect of the category of repair complexity on labor content and the cost of overhauling a horizontal boring machine model 2631 with categories of repair complexity per Table 1: $R_м$ = 25 URC (YeSPPR) and $R_м$ = 65 (ENIMS [Experimental Scientific Research Institute of Metal Cutting Machine Tools]). Time standard for repairing 1 URC is 35 standard hours. The 4th-class tariff rate is R0.627. Thus, according to YeSPPR, labor content is 35 x 25 = 875 standard hours and the cost is 0.627 x 875 = R548.63. According to ENIMS recommendations, labor content is 35 x 65 = 2,275 standard hours and the cost is 0.627 x 2,275 = R1,426.43. One can see from the example that one can "err" by a factor of 2.6 in computing labor content of repairing a machine tool.

Therefore, enterprises that use equipment are at a loss when it comes to deciding which source and which category of repair complexity to use in their computations. When one takes into account that repair complexity is used for determining all economic indices of repair departments' performance, one can easily see what the correct computation of categories of repair complexity means.

Analysis of annual PPR [scheduled preventive repairs] schedules at the industry enterprises has also demonstrated that there is no unity in established categories of equipment repair complexity used by plants in performing technical and economic computations (Table 2).

Table 2

	Category of repair complexity, URS, of				
	Lathes model			Vertical lathes model	
Enterprise	16K20	1M63	165	1516Ф1	1531M
PO "Novokramatorskiy mashinostroitelnyy zavod"	15.0	15.0	24.0	36.0	34.0
PO "Bryanskiy mashinostroitelnyy zavod" imeni V.I. Lenin	12.0	--	24.0	39.0	28.0
Tula Railroad Machine Building Plant imeni M.I. Kalinin	12.0	15.0	24.0	--	--
PO "Zhdanovtyazhmash"	11.0	14.0	26.0	60.0	31.0
PO "Kran" (The town of Uzlovaya)	12.5	20.0	--	--	--

One can see from Table 2 that due to the lack of clear recommendations on repair complexity enterprises, make deviations, so both labor content of repair work and the number of repair workers can be subjective. It seems feasible, in light of the Resolution of the CPSU Central Committee, the USSR Council of Ministers and VTsSPS [the All-Union Central Council of Trade Unions] "On Improving Organization of Payroll and Introducing New Tariff Rates and Salaries for Workers of Manufacturing Sectors of the National Economy," to give production associations, enterprises and organizations all necessary normative documents which will enable them to make appropriate decisions.

It is high time to solve the most important problems of repair:

--accelerate the release of the new edition of the unified system of scheduled preventive repair and rational operation of technological equipment of machine building enterprises;

--accelerate the decision on the use of a unified (two- or three-stage) system of e repair. At present, a three-stage system (routine repair, medium repair and overhaul) is used for technological and material handling equipment, and a two-stage system (routine repair and overhaul) is used for power generating and communications equipment. Because each production department has equipment of both types, it is difficult for maintenance mechanics and electricians to coordinate equipment repair schedules;

--organize quality control of repairs on the part of QC departments;

--provide enterprises with an approximate list of unique and especially sophisticated equipment, because according to the above Resolution repair and maintenance of this equipment can be paid for according to the first group of tariff rates;

--organizations responsible for providing machine building enterprises with methodological and directive materials must develop unified recommendations listing repair complexity of every model, which will eliminate variations in determining labor content and the cost of repair and the number of repair workers.

Solutions to these problems will make it possible to put in order repair departments at enterprises and increase their accountability for the quality and timeliness of equipment repair.

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UTILIZATION OF FIXED ASSETS IN METALWARE MANUFACTURING CRITICIZED

81442826j Moscow MASHINOSTROITEL in Russian No 3, Mar 88 pp 32-33

[Article by V.G. Savchenko, I.I. Postoyev, Ye.D. Postoyeva, and N.T. Savchenko: "Improve Utilization of Fixed Assets in Metalware Manufacturing"]

[Text] Under the current conditions of renovation of the machine building industry based on updating and replacement of technological equipment, intensification of fixed assets utilization and increased return on investment become very important. Experience of the Volgograd Tractor Parts and Metalware Plant demonstrates that solution to the problem is not simple. Plant reconstruction conducted in 1970-1980 made it possible to increase production volume almost fiftyfold, compared to the first post-war year. But implementation of new technology was lagging behind the production renovation process, and return on investment was decreasing. As a result of further modernization and equipment replacement, production volume increased during the last five-year plan by a factor of 53. During this period, plant reconstruction was bringing good results, and return on investment was increasing: in 1985 it was 13 percent higher than in 1980.

It should be noted that increase in return on investment not only depends on the degree of equipment and technology perfection, but also on the human factor (workers' attitude to their work and to discipline), which in turn depends on production, domestic and living conditions and personnel skills and turnover. As a result of fulfilling the five-year plan of social development of the plant collective, living conditions had been improved, which resulted in reduced turnover and improved skills of the personnel and made it possible to man the new nut manufacturing shop which has the newest equipment. Due to all these factors labor productivity increased 33 percent.

During the current five-year plan production development and retooling continue. As a result of workstation certification, 72 workstations have been eliminated and 117 workers have been conditionally freed up; they now work on new, mainly automatic equipment. In 1987 it is planned to free up 100 pieces of obsolete equipment and 400 m^2 of production area, where new highly-productive equipment will be installed. During these years, the level of mechanization at the plant will reach 80.3 percent. Fixed production assets will increase 57 percent, and annual production output

will increase 35 percent, i.e., fixed production assets will grow faster than labor productivity.

Critical analysis of utilization of fixed assets and implementation of new and replacement of obsolete technological equipment made it possible to reveal a number of unfavorable factors, such as:

--the plant does not have all necessary new equipment;
--a low technical level of press equipment provided to the plant;
--shortage of skilled personnel.

The low technical level of equipment results in fixed production assets growing faster than labor productivity, i.e. high cost of equipment does not match its qualitative parameters, and first of all labor productivity. The effect of this factor on return on investment becomes apparent if one presents return on investment as the ratio of labor productivity Π to fixed production assets Φ_{Tp}.

$$f = \frac{Q}{\Phi_0} = \frac{\Pi}{\Phi_{Tp}}$$

where Q is annual production output, R, and Φ_0 is average annual cost of fixed assets, R.

Obviously, when fixed production assets grow faster than productivity, return on investment decreases. This can be seen when expensive and low-productivity equipment is implemented.

Combined effect of the above unfavorable factors results in lower return on investment of all plant assets. During the current five-year plan this decrease will be equal to 10 percent. Therefore, measures aimed at overcoming the negative effect of these factors have been developed. In order to operatively solve problems of retooling, a group comprised of the most experienced specialists has been created in the Manufacturing Engineering Department. Its main goal is to create new types of equipment that would make it possible to accelerate plant retooling. A production department that manufactures nonstandard equipment has been organized and functions successfully. Obsolete equipment is being modernized, and automatic machines are combined into automatic lines.

An integrated approach to solving technical problems not only makes it possible to increase the degree of fixed assets utilization, but also the level of labor mechanization, while decreasing metal content of products, improving product quality and reducing personnel requirements. However, this is achieved at the expense of a higher rate of growth of capital expenditures and fixed production assets. Shortage of skilled workforce is being eliminated due to freeing up workers. Thus, replacement of technological equipment with new, more productive machinery, modernization of obsolete equipment and elimination of a number of workstations (in accordance with certification results) make it possible to man new production departments.

It is only possible to overcome faster growth of fixed production assets compared to the growth of labor productivity on the basis of improved quality of design of press equipment, which makes it possible to use scrapless technological processes in manufacturing fasteners, using hot and cold upsetting. The plant needs this repair for manufacturing fasteners made of stronger steels. Manufacturing of bolts made of 45 Cr steel, instead of low-carbon steel, for use in more powerful tractors is an example of this approach. However, the available press equipment is not powerful enough. This is why the plant modernizes cold-upsetting presses, converting them to hot upsetting of bolt heads with local induction heating of blanks. The plant's transition, following the example of Leningrad enterprises, to a two- and three-shift operation will also facilitate efficient utilization of the active part of fixed assets. This will make it possible to combine accelerated renovation of the machine tool fleet with increased utilization ratio and shift coefficient of the most productive equipment. In 1986, the plant had the following shift distribution of workers: 70, 21 and 9 percent during the 1st, 2d and 3d shift, respectively (shift coefficient 1.68); by the end of the five-year plan the distribution will change to 50, 33 and 17 percent, respectively (shift coefficient 2).

As a result of converting the most productive equipment to the two- and three-shift operation, 280 pieces of obsolete equipment and 1,800 m^2 of production area will be freed up (equipment utilization ratio 0.9). Unique automatic equipment, including CNC machine tools, will be utilized even better (utilization ratio 2.5).

High-skilled workers are needed for serving and maintaining sophisticated new equipment, including CNC equipment. To solve this problem, the plant conducts specific-purpose training of workers.

The dynamics of growth of production output, fixed assets, return on investment and other technical and economic indicators demonstrates that during the current five-year plan the rate of growth of fixed assets will be higher than the rate of growth of production output, which will temporarily result in a certain decrease in return on investment. The plant has assumed an integrated approach to solving retooling problems. This approach makes it possible to sharply increase the rate of growth of the output of tractor parts and hardware the industry needs so badly, and will improve utilization of fixed assets.

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UNIFIED APPROACH TO DEVELOPMENT OF STATUTES OF STRUCTURAL SUBUNITS

81442826i Moscow MASHINOSTROITEL in Russian No 3, Mar 88 pp 31-32

[Article by L.F. Klimkina, V.P. Oderiy, and A.I. Trifonova]

[Text] Organization of management is one of the most important factors in the course of comprehensive improvement of the quality and efficiency of industrial production. The enactment of the USSR Law "On Labor Collectives and Improving the Role Thereof in Managing Enterprises, Institutions and Organizations" is aimed at strengthening the State, plan and labor discipline and broaden involvement of workers in production management.

Statues of structural subunits that are currently in effect at enterprises do not take into account the requirements of the Law, whereas they should cover functions, objectives and relations that make it possible to provide reasonable division of labor and facilitate transition to progressive and flexible organization thereof, characterized by collective responsibility for optimum fulfillment of plan targets and fast response to new requirements, and planned objectives of collective's activity. This will provide a unified approach to solving problems that facilitate increased production efficiency and creation of a flexible production management system.

Analysis of statutes now in effect at enterprises has demonstrated that in identical structural subunits at various enterprises in the same industry functions, objectives and interactions differ significantly, and implementation of individual objectives is duplicated. This has brought up the need for centralized rework of typical solutions, in order to provide a unified approach to the development of statutes of structural subunits while taking into account specific character of production and business activity of concrete enterprises.

Taking into account requirements of the law on Labor Collectives, Mintyazhmash SSSR [USSR Ministry of Heavy and Transport Machine Building] NOT [industrial engineering] Center developed in 1985 typical states of the following structural subunits of production associations and enterprises: plant management office; central plant accounting office; departments of S&T information, construction, planning and economics, production and inventory control, organization of work and payroll, material and technical supply, outside cooperation, finance, personnel, sales, technical training,

quality control, labor safety, legal, business support, technical documentation; office; laboratory of production economics and organization; and audit and inspection group.

Each typical statute includes general provisions, principal tasks, structure, functions, department's interaction with other subunits of the enterprise, rights and responsibilities.

The "General Provisions" section formulates the organizational status and subordination of the department, the procedure for appointing the department manager and the required level of his or her professional qualifications, and lists normative documents that regulate the department's work.

The "Principal Tasks" section lists subunit's task in accelerating the social and economic development of the country and improving management systems and business methods on the basis of wide implementation of achievements of S&T progress, better organization and discipline and improved style.

The "Structure" section defines the composition and interrelations of subunit managing bodies.

The "Functions" section lists functions peculiar to the subunit and needed in order to perform tasks the department is charged with, and the collective's duties and responsibilities (highly productive work, practical implementation of Party decisions, strict execution of Soviet laws and government resolutions, fulfillment of State plans and contractual obligations, improving the efficiency and quality of work, strengthening labor, production and State discipline, constant care of developing work and sociopolitical activity of members of the collective and educating them in the spirit of moral principles of builders of Communism).

Section "Department's Interaction With Other Subunits of the Enterprise" formulates organizational and technical relations established in the manufacturing process between structural subunits in areas of planning, financing, management, material and technical supply and sales, robotization and mechanization of production, personnel training, handling of paperwork, legal matters, etc.

The "Rights" section covers the scope of rights that follow from the law on Labor Collectives and are necessary and sufficient for the department to perform the functions it is charged with, and procedures for realization of these rights. The section defines principal rights and responsibilities of labor collectives and their power in managing production, based on harmonious combination of State, society, collective and personal interests, one-man management and the unity of rights and responsibilities.

Each structural subunit is responsible for observing the legislation on guarding socialist property and rational utilization of material and financial resources; for manufacturing high-quality and standard products; for providing a high level of planning the work along the directions of

subunit's activity; for performing tasks and functions the subunit is charged with; and for compliance of all documents coming out of the subunit with active legislation and orders and instructions of higher bodies, the enterprise management, etc. (the "Responsibilities" section).

The typical statutes will make it possible for enterprises to develop working statutes that take into account specific conditions of their production and business activity.

Implementation of the Industrial Engineering Center developments at the industry enterprises has demonstrated that typical statutes are being used in compiling plant statutes of structural subunits and form efficient means for improving organizational structures of management and improving the efficiency of managerial labor, reducing labor content of developing statutes for the enterprise subunits, and conditional reduction of the number of employees.

At present, the Mintyazhmash Industrial Engineering Center is developing typical statutes for technical departments of enterprises not covered by the collection "Typical Statutes of Structural Subunits of Production Associations and Enterprises" published in 1985.

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INTEGRATED PROGRAM FOR DEVELOPMENT OF LABOR SAFETY MANAGEMENT

81442826a Moscow MASHINOSTROITEL in Russian No 2, Feb 88 pp 14-15

[Article by Candidate of Juridical Sciences Sh.D. Dzoblayev, Candidate of Technical Sciences A.Ye. Perminov and Engineers B.S. Kukayevskiy and Yu.V. Timofeyev under the "Labor Safety and Environmental Protection" rubric]

[Text] Under the new business conditions the importance of labor safety management increases. Analysis of causes of industrial traumatism and professional illnesses demonstrates that by providing safe equipment and technology one can only partially solve the labor safety problem at enterprises. The goal is to develop a labor safety management system wherein the problem of revealing the essence of the management process and the character of interrelation and interaction of individual links of the system takes the front seat. An integrated program for development of an industry labor safety management system, wherein implementation of the system is based on new in principle scientific and methodological foundations and the technical standards documentation existing at an enterprise (association) and in an industry is an efficient and expedient method for solving this problem.

The integrated program should be developed with consideration given to a preliminary comprehensive analysis of organizational forms and methods for implementation of management functions in specific-purpose subsystems. Specific-purpose subsystems include the management of: safety of production equipment, technological processes, buildings, structures and premises and means of transportation and providing individual protection devices and medical and preventive services to workers; work and rest schedules, creation of normal sanitary-hygienic conditions, professional selection of workers and labor safety training. Functional management links between subunits are presented in a matrix form. Organization and regulation of the management process within the framework of concrete specific-purpose subsystems are formalized by a technical standard document (statute) that describes activities of management bodies and officials, which is directed at ensuring labor safety and consists of performance of certain functions and application of respective management methods and principles.

Improvement of the labor safety management system involves development of a management functions classifier, which consists of a list of functions performed by management bodies and officials and the contents and character

of their activities in the process of performing specific functions. Also, in each functional subsystem a matrix of functions is developed, as well as rules for organization of: scheduling of labor safety jobs (measures); control and supervision of labor safety provisions; registration, analysis and assessment of the labor safety situation; material and technical support of labor safety and material incentive measures; execution and coordination of labor safety work at enterprises.

Organizational and legal support of the labor safety management system is very important. Taking into account results of analysis of State and industry normative acts on labor safety, a set of normative legal documents that support the labor safety management process at an enterprise (association) should be developed on the basis of the management functions classifier. In doing this, a coordinated system of management functions the management bodies and officials are charged with according to normative documents is identified. Organizational forms of interaction of subunits within and outside of the management body with higher (control and supervision, trade union and public health) bodies are established. It is feasible to develop a Statute on implementation by labor collective of production departments, teams and enterprises of their rights in the area of labor safety in accordance with the USSR Law "On Labor Collectives and on Increasing Their Role in Managing Enterprises, Institutions and Organizations," as well as a Statute on organization of work on creating safe labor conditions on teams.

An integrated program as a scientific and methodological basis of the labor safety management system at the enterprise (association) level can be presented in the form of a chart that contains information on a problem title, the type of technical standard documentation to be developed, executors, due dates and program implementation stages.

The integrated program elaborates on main problems in the development of a labor safety management system. The first section of the program includes analysis of organizational forms and methods for realization of management functions and on this basis develops a management system within the framework of specific-purpose subsystems. Development stages are as follows: determining the object of management at the specific-purpose system level; structurization of safety management functions in accordance with the "Organization-Execution-Control" scheme; determining the object of management according to functions; planning, analysis, control and record keeping within the framework of a specific-purpose subsystem; structurization of functions of planning, analysis, control and record keeping; constructing a model of resource support of program stages at the specific-purpose subsystem level in accordance with the schemes "Objectives-Resources," "Objectives-Due Dates" and "Resources-Due Dates." Based on derived data, one develops a Statute of Organization and Regulation of the Management Process in Specific-Purpose Subsystems, such as "Managing Production Equipment Safety" and "Managing the Safety of Buildings, Structures and Premises."

The second section of the integrated program deals with the development of an integrated labor safety management system at the enterprise

(association) level, which includes the following stages: determining the object of management at the association level; constructing a model of the object; creating a classifier of labor safety management functions at the association, in order to determine boundaries of interaction of management bodies; and systematization of management functions in the area of labor safety at the association in accordance with features of functional subsystems. The following functions are systematized: control of labor safety provisions; management of planning and forecasting the work on labor safety; record keeping, analysis and assessment of labor safety; and material and technical support of measures aimed at creating safety labor conditions. Each stage ends with the development of a Statute. According to the Statute, establishment of interrelations and coordination of activities at all levels of the association management structure are regulated by the enterprise standard on organization of the labor safety management process.

The third section of the integrated program deals with the development of organizational and legal support of the labor safety management system at the association. Based on the analysis of State and industry normative acts on labor safety, a set of normative legal documents is developed, which includes the following provisions: on normative legal documents supporting the labor safety management process at the association; on organizational forms of and methods for interaction between the association management and higher inspecting and supervisory bodies; on the use by labor collectives of production departments, teams and enterprises of their rights in the area of labor safety in accordance with the USSR Law "On Labor Collectives and on Increasing Their Role in Managing Enterprises, Institutions and Organizations"; and on organization of work on providing safe labor conditions in a team.

The development of a labor safety management system based on a common structure for all levels, which is determined with consideration given to the set of objects of management and management inputs and uses common information support makes it possible to use computers for improving the quality of analysis and making sound real-time decisions. This is why the integrated program includes a section on ASU [automated management system] development. The section describes solutions to the following problems:

--studying the possibility of using computers in the area of labor safety management at the association;

--developing recommendations for creation of ASU "Labor Safety";

--development of the working project of ASU "Labor Safety" which contains principal technical decisions and specifies the scope of documentation on the functional portion of ASU "Labor Safety" and its mathematical, information and programming software, as well as experimental operation of the ASU at base enterprises of the association and transferring it for production use at the association.

As a result of implementation of the integrated program for the development of the labor safety management system, a set of enterprise standards (ES)

which are functioning under an automated labor safety management system (ALSMS) is created at the association enterprises. A set of these standards forms the normative base. Its objective and purpose is to establish unified rules and provide standardization at the enterprise (association) level in order to regulate activities in the area of labor safety. it is developed based on the system of labor safety standards and industry standards, takes into account specific conditions of enterprises (associations) and provides unified systemic approach to selecting methods and means for automating the labor safety management process. A set of such standards should be developed as an integrated system of enterprise (association) standards in labor safety management that has an objective of providing rational planning of work and managing individual sections within the framework of the enterprise (association) authority.

ES ALSMS should reflect: methods for and forms of decision-making in the process of labor safety management at all levels, while widely using modern means for data transmission, storage and processing; information support of labor safety management and documentation system, using machine data carriers; methods for selection, placement, training and retraining of personnel charged with labor safety; putting in order (if needed) the organizational structure of labor safety management; and the procedure for the development of job descriptions and statutes of departments (subunits) that handle labor safety problems. Components of the set of enterprise standards must facilitate the improvement of management functions along all directions of work on labor safety and in accordance with management levels. In doing this, one must take into account the existing structure of the enterprise management system, flows of economical and social information and the forecast for changes therein, and the technology of planning and management.

Development of the set of ES ALSMS based on the integrated program must be oriented toward solving both the existing and new problems, implementation of which with the help of modern management methods and means can significantly improve the efficiency of organization of work in the area of labor safety.

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DESIGNING TORQUE-SPEED CHARACTERISTIC OF PERMANENT-MAGNET AND RECTIFIER MOTOR

186102341 Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 17 Apr 87) pp 41-45

[Article by A.N. Lebedev, engineer]

[Abstract] An analytical method of designing a motor torque-speed characteristic most closely approximating the ideal one for a given application over a given speed range is outlined, a brushless 3-phase rectifier motor with 4-pole permanent-magnet field and 6-transistor bridge commutator serving as an example on which this method is demonstrated. The commutator is controlled by a rotor position transducer, through a signal amplifier and a pulse shaper. The system includes also three 3-phase electronic switches, a logic circuit, two-square-pulse generators, and two electronic relays. Both starting and running are covered: starting without load or under load and running through transient to quasi-steady rotor oscillation. The torque-speed characteristic is shown to be dependent not only on the stator winding pattern but also on the selection of commutator transistors with respect to voltage and current ratings. Figures: 4; tables: 2; references: 7 Russian.

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UDC 62-83:621.313.2:621.382.233.026

IMPROVING DYNAMIC CHARACTERISTICS OF DIRECT-CURRENT DRIVES WITH THYRISTOR CONTROLS

18610234h Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 23 Jun 87) pp 27-31

[Article by A.G. Ivanov, candidate of technical sciences; and I.I. Ushakov, engineer]

[Abstract] Thyristor control of a d.c. motor for industrial robots and machine tools with numeric program control is examined, the preferred scheme with an internal current loop and subsidiary speed regulation featuring adequate dynamic range and bandwidth. Following a general analysis of such a system by the method of transfer functions according to the theory of automatic control systems, with a linearizing but also bandwidth-limiting device in the structure, single-loop regulation is considered with a PID speed regulator and only a current-limiting device. Next is proposed two-loop regulation with a PI current regulator in addition to the current-limiting device and the PID speed regulator. The advantages of this scheme are independent current and speed settings and that the corrective circuit of the current-limiting device does not influence the speed regulation dynamics. Figures: 3; references: 3 Russian.

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UDC (62-83:621.313.323:621.382.233.026).001.5

ELECTRIC DRIVES ETS1 WITH SYNCHRONOUS MOTORS AND THYRISTOR CONTROLS

18610234d Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 17 Apr 87) pp 14-17

[Article by V.V. Gorchakov, candidate of technical sciences, M.I. Altshuller, candidate of technical sciences, A.A. Sushentsov, candidate of technical sciences, V.L. Sayevich, engineer, and V.A. Kashirskiy, engineer]

[Abstract] An electric drive using a brushless synchronous motor with $SrFe_{12}O_{19}$ high-energy permanent magnets on the rotor and a directly coupled thyristor frequency converter with natural current commutation has been invented at the All-Union Scientific Research Institute of Relays. Speed is regulated through two loops with a PI-regulator and current control. The motor is controlled in the starting mode as well as in the running mode. Only one energy conversion takes place in the system with a directly coupled thyristor converter, which contributes to efficient operation and simplifies the construction. The motor is built in three sizes with 132 mm, 160 mm, 180 mm shaft height, respectively, the maximum speed of all being 1,500 rpm, for two versions of this series ETS1 drive with thyristors having 50 A and 100 A current ratings, respectively. The drive is designed for operation from a 380 V - 50 Hz power line, but can be adapted for other voltages (220, 400, 415, 440, 500) and 60 Hz. Figures: 1; tables: 1.

2415/9365

UDC (62-83:621.313.323).001.24

EFFICIENT STRUCTURES OF MAIN ELECTRIC DRIVES WITH NONSALIENT-POLE SYNCHRONOUS

18610234g Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 2 Dec 86) pp 24-27

[Article by S.L. Royak, candidate of technical sciences; B.M. Bochenkov, engineer; G.V. Ryazanovskiy, engineer; and Ya.V. Chupin, engineer]

[Abstract] A performance analysis of a nonsalient-pole synchronous motor with wound exciter based on the theory of a.c. electric machines and aided by the appropriate phaser diagram demonstrates its suitability, in preference to an induction motor with frequency converter, for the main electric drive in metal processing machine tools which require drives with nominal speeds within the 6,000-12,000 rpm range and an up to 10:1 range of speed regulation at constant power. The regulation system includes a current invertor, a voltage invertor, and a rotor position indicator. Five regulation schemes are evaluated comparatively in terms of copper losses and iron losses, which determine the efficiency. In the first scheme for constant-power speed regulation the armature current is variable, the field current remaining constant. In the second scheme for constant-power or constant-torque speed regulation the angle between armature current and e.m.f. is variable, both armature current and field current remaining constant. In the third scheme for constant-power speed regulation the armature voltage is variable, while the field current and the angle between armature voltage and e.m.f. remain constant. In the fourth scheme for constant-power speed regulation the angle between armature voltage and e.m.f. is variable, both armature current and field current remaining constant. In the fifth scheme for constant-power speed regulation, the only one with the speed regulator feeding the torque-setting signal to the exciter rather than to the motor, the field current is variable and the armature voltage remains constant. Figures: 3; references: 3 Russian.

2415/9365

UDC (62-83:53.087.92).001.3

COMPOSITE TRANSDUCERS FOR DIRECT-CURRENT AND ALTERNATING-CURRENT DRIVES

18610234e Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 pp 18-20

[Article by V.M. Nikitin, candidate of technical sciences, A.S. Fedotov, engineer, V.M. Pimenov, engineer, L.V. Safronova, engineer, F.S. Pronina, engineer, and A.G. Khirov, engineer]

[Abstract] Two transducers have been developed by the All-Union Scientific Research Planning and Design Institute of Automatic Electric Drives for Industry Agriculture and Transportation (Moscow), together with the VNIIR (Cheboksary) and the VNIIMEM (Leningrad), for automatic control of d.c. and a.c. drives operating with machine tools and industrial robots in automatic flexible production systems. They produce all signals necessary for high-precision closed-loop speed and position control. Both the PDF-8 for smaller motors and the PDF-9 for larger motors include a brushless d.c. or synchronous tachometer-generator, a photoelectric converter, a photopulse detector forming discrete signals for the servomechanism, and a photopulse detector forming discrete signals for the indicator of rotor position. The electronic commutator of the tachometer consists of three transistor pairs and NAND logic. Each photodetector consists of an FD256 photodiode pair, a fifth FD256 photodiode being place in the reference channel. All the electronics, including also K157UD2 operational amplifiers and AOL107 indicator light-emitting diodes, are mounted on two printed-circuit boards. Both transducers have hollow shafts with a tapering bore for direct mounting on the conical free shaft extension of the drive motor.
Figures: 2; tables: 1.

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DIRECT-CURRENT MOTORS FOR MACHINE TOOLS, ROBOTS, AND OTHER INDUSTRIAL MECHANISMS

18610234b Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (17 Apr 87) pp 5-10

[Article by N.V. Donskoy, candidate of technical sciences, A.G. Ivanov, candidate of technical sciences, V.M. Nikitin, candidate of technical sciences, Ya.M. Kupchan, engineer, V.M. Pimenov, engineer, and I.I. Ushakov, engineer]

[Abstract] A new generation of direct-current motors with built-in tachometer generator for various drives in machine tools and industrial robots has been developed toward the end of the 11th Five-Year Plan period and is now commercially produced. The line of these motors covers the 0.6-170 N·m torque range and the 1.5-250 kW power range. It includes types P, D, M, Ye with thyristor controls and two reversible low-inertia models with speed feedback through a PI-regulator as well as current feedback through an optron and with protection against open circuit in the tachometer loop. They are designed for operation some from a 3-phase powerline and some from a single-phase power line through matching transformer or without transformer and a bridge rectifier. Another new special line is multicoordinate motors with transistor controls and built-in brake as well as tachometer, for machine tools with numeric program control. Figures: 4; tables: 1.

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STATUS OF AND OUTLOOK FOR DEVELOPMENT OF ELECTRIC DRIVES FOR MACHINE TOOLS AND INDUSTRIAL ROBOTS

18610234a Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 17 Apr 87) pp 2-4

[Article by A.D. Pozdeyev, doctor of technical sciences, V.S. Makurin, engineer, A.I. Kondrikov, candidate of technical sciences, A.A. Kirillov, candidate of technical sciences, and V.V. Gorchakov, candidate of technical sciences]

[Abstract] Conversion of manufacturing plants to fully automatic flexible production modules, lines, and systems requires that electric drives for the machine tools and for the industrial robots operating them must be of minimum weight and size to ensure economy of materials and space as well as efficient cooling, must be designed for higher speeds, and must be produced so as to ensure maximum reliability and minimum fault locating and clearing time. Electric motors meeting these requirements are being produced in the USSR since the beginning of the 1980's. They include synchronous motors with permanent-magnet excitation and transistor, thyristor, or transistor-thyristor controls, 2-phase reversible induction motors with transistor or thyristor controls, and direct-current motors. Special motors are to be produced during the 12th Five-Year Plan period: synchronous motors using powerful permanent magnets, some including rare-earth elements, with 0.035-170 N·m torque rating and 2,000-6,000 rpm maximum speed, induction motors with 1.5-45 kW power rating, d.c. motors with 2-200 kW power rating and 7,000-3,000 rpm top speed including a 4:1 or 5:1 range of speed regulation at constant power. There is a parallel trend toward universal electric drives. Progress in development of electric drives for robotized industry will depend on progress in power semiconductor devices, typically transistor-diode modules, in magnet materials, and also in single-chip special-purpose minicomputers. Tables: 2.

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USING SIMULTANEOUS MOVEMENTS OF HYDRAULIC MECHANISMS IN INDUSTRIAL ROBOT FOR REDUCTION OF ENERGY LOSSES

18610110b Moscow MASHINOSTROYENIYE in Russian No 6, Nov-Dec 87 (manuscript received 12 May 86, after completion 20 Jan 87) pp 46-51

[Article by Ye.A. Tsukhanova and P.V. Zenchenko, Moscow]

[Abstract] Control of hydromechanical drives in industrial robots is proposed which, by using interaction of the arm translation mechanism and the column rotation mechanism, minimizes the pressure in the hydraulic loop and thus the energy losses overall. Mathematical treatment of the problem is facilitated by partitioning the drive system into its hydraulic and mechanical parts so that fluid forces driving the hydraulic output member become external forces acting on the mechanical part. Design and performance analysis of such a control, with the working fluid assumed to be incompressible, involves comparing simultaneous movements and sequential movements of the two mechanisms. The pressure loss in each is approximated by quadratic functions of the gripper velocity along the mechanism's axis of motion and the angular velocity of the column. Calculations, assuming negligible leakage in pump and valve, reveal the advantage of simultaneous movements with the corresponding equation of flow being one of holonomic nonsteady interaction. The algorithm of velocity control through regulation of pressure and acceleration is constructed on this basis for computer control of any given industrial robot, such as one considered here for illustration. Figures: 4; references: 7 Russian.

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ELECTRIC DRIVES FOR MECHANISMS OF INDUSTRIAL ROBOTS

18610234f Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 14 May 87) pp 21-24

[Article by L.A. Shpigler, candidate of technical sciences, A.B. Gudzenko, candidate of technical sciences, and Ye.A. Smotrov, candidate of technical sciences]

[Abstract] Design and performance of electric drives for industrial robots are analyzed in accordance with the theory of automatic control. The control object is described by a system of differential equations in state variables and the transfer function of the total regulation system is represented by its Laplace transform, matrix notation being used for both. For calculation of transients and damping characteristics, the overall dynamic model is decomposed into simpler two-mass components, interaction between components being evaluated by the second Lagrange method. Three types of mechanisms with different ranges of performance characteristics are considered as control objects: feed mechanisms, machining mechanisms, and assembly mechanisms. Two types of drive are recommended as most suitable for industrial robots and machine tools with numeric program control: the EShIM1 with d.c. motor and the EPB-2 with synchronous motor. The synchronous motor has Sa-Co permanent magnets and a more intricate construction, which contribute to a higher cost. This drive, gearless high-speed, is therefore only for fast assembly involving several partial cycles. Adaptive control with inductive acceleration transducers is recommended for ensuring invariability of transients and suppressing elastic vibrations. Figures: 5; tables: 1; references: 1 Russian.

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UDC (62-83:621.313.323:621.382.233.026).001.3

ELECTRIC DRIVE WITH TRANSISTOR CONTROLS BASED ON SYNCHRONOUS MOTOR WITH PERMANENT-MAGNET FIELD FOR MACHINE TOOLS AND INDUSTRIAL ROBOTS

18610234c Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 17 Apr 87) pp 10-14

[Article by A.D. Pozdeyev, doctor of technical sciences, V.V. Gorchakov, candidate of technical sciences, N.V. Donskoy, candidate of technical sciences, V.M. Nikitin, candidate of technical sciences, I.I. Kuklin, engineer, V.M. Pimenov, engineer, and O.A. Serkov, engineer]

[Abstract] An electric drive using a synchronous motor with permanent magnets in a rotating-field construction and with speed regulation by means of power transistors has been developed in 1983 at the All-Union Scientific Research Institute of Relays in Chuboksary and is since 1985 commercially produced as model EPB1 for machine tools and industrial robots. The motor is built in three sizes with 90 mm, 100 mm, 112 mm shaft height, respectively. Each has a bandwidth of 100 Hz and a 1:10,000 range of speed regulation. The maximum speed is 1,500 rpm (sizes 90 and 100) and 1,000 rpm (size 112), the torque at the lowest speed being 13 N·m, respectively. An electromagnetic brake can be built in. The modification EPB2 has better load characteristics and almost no speed oscillations. The drive can be modified into a multicoordinate one for machine tools with numeric program control. Figures: 4; references: 2 Russian.

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UDC (62-83-529:621.9.06).001.24

SYNTHESIS OF PROGRAMMABLE REGULATORS FOR ELECTRIC DRIVES OF MACHINE TOOLS AND INDUSTRIAL ROBOTS

186102341 Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 17 Apr 87) pp 31-34

[Article by V.M. Vodovosov, candidate of technical sciences]

[Abstract] A universal microcomputer-programmed regulator with pulse-phase control for d.c. drives of machine tools and industrial robots, one which ensures high stability of operation, is synthesized according to the principle of subsidiary regulation on the basis of a linearized model of the d.c. motor and a discrete model of the regulation system. Transients are calculated by the method of transfer functions. The discrete model of the regulation system with a PID speed regulator and P position regulator is first obtained by discretization of the analog model and includes, accordingly, an angle-to-code converter in the feedback loop and a code-to-analog converter which couples the regulator to the transducer, with compensation of the extra time delay due to this additional conversion and with compensation of the speed error. The discrete model is also obtained directly, by use of the euler method for solving the equations of motion and energy conversion. Including subsidiary regulation in the program is one way to ensure satisfactory direct digital control of machine tools with such drive, high stability of such a regulation system being ascertainable by a Schur-Cohn test. Figures: 4; tables: 2; references: 3 (2 Russian, 1 Western (?) (in Russian translation)).

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OPTIMIZATION OF CONTROL SYSTEMS FOR ELECTRIC DRIVES OF INDUSTRIAL ROBOTS

18610234j Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 19 Jan 87) pp 34-37

[Article by V.N. Afanasyev, doctor of technical sciences, F.G. Bukreyev, candidate of technical sciences, and V.S. Titov, candidate of technical sciences]

[Abstract] The problem of optimizing the control system for electric drives of industrial robots is solved first analytically and the numerically by algorithmic synthesis of nonsteady systems on the basis of incomplete information, specifically on the basis of the Hamiltonian on the optimum trajectory, the gist being to construct a control equation which will both minimize the appropriate control quality functional and stabilize the closed "regulator-state variables sensor (measurer)" loop. The method is demonstrated on a control system for an electric drive with pulse width modulation, its mathematical model being put in the form of a vector-matrix equation: state vector at discrete instant of time t equal to state vector at preceding discrete instant t-1 multiplied by F(t) plus control action at preceding discrete instant t-1 multiplied by G(t), F(t) and G(t) being transient matrixes of unknown drive parameters. Numerical analysis has yielded a typical speed transient and the readjustable transfer ratio as function of time, with the optimization loop first open and then closed. Figures: 2; references; 5 (4 Russian, 1 Western (in Russian translation)).

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STANDARD SERIES OF RECTIFIER AND PERMANENT-MAGNET MOTORS FOR MACHINE TOOLS AND INDUSTRIAL ROBOTS

18610234k Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 16 Jun 87) pp 37-40

[Article by N.P. Advolotkin, A.G. Vdovikov, Yu.I. Vyplavin, S.A. Gevoyan, Ye.I. Malykhin, M.Ya. Morozovskiy, and I.Ye. Ovchinnikov]

[Abstract] A standard series DVU of rectifier and permanent-magnet motors has been developed in the USSR for machine tools and industrial robots, this type of motors most advantageously combining high speed and high overload capacity with excellent controllability and low cost. The stator is a square welded laminated structure carrying a 3-phase winding in slots around the bore and directly bolted between two endshields. The rotor is a hexagonal laminated structure mounted directly on the shaft and carrying six permanent-magnet pole pieces. The permanent magnets are made of $SrFe_{12}O_{19}$ ferrite, with a coercive force of 240 kA/m and a remanence of 0.38 T. Axial ducts in the rotor core under the interpolar spaces reduce the moment of inertia. An electromagnetic emergency brake can be mounted in the front endshield, such a brake to be later replaced by a permanent-magnet one with better dimensional and performance characteristics. Elimination of the housing not only simplifies the technology of motor manufacture including assembly but also improves the heat transfer from the stator winding and thus the motor cooling. Either the stator slots or the pole pieces on the rotor are skewed. The six sizes of this series are: DVU165S with maximum torque 7.5 N·m and speed 2,500 rpm, DVU165M with maximum torque 10.0 N·m and speed 2,000 rpm, DVU 165L with maximum torque 13.0 N·m and speed 2,000 rpm, DVU215S with maximum torque 17.0 N·m and speed 2,000 rpm, DVU215M with maximum torque 23.0 N·m and speed 2,000 rpm, DVU215L with maximum torque 35 N·m and speed 2,000 rpm. Their material economy is characterized by an output constant which increases with motor size over the 0.37-0.46 N·m/kg range at room temperature, the mechanical time constant decreasing correspondingly over the 7.9-4.4 ms range. The quality of these motors is comparable with that of Honeywell and Porter motors produced in the United States and Bosch, Siemens, Stromag motors produced in West Germany. Figures: 3; tables: 1; references: 2 Russian.

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UDC 621.313.2-52.001.4

DESIGN OF RECTIFIER MOTORS WITH DISK ROTOR FOR ELECTRIC DRIVES OF MACHINE TOOLS AND INDUSTRIAL ROBOTS

18610234m Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 88 (manuscript received 14 May 87) pp 45-48

[Article by A.F. Sromin, engineer, All-Union Scientific Research Institute of Electrical Machines]

[Abstract] A method of designing rectifier motors with disk rotor for machine tool and industrial robot drives is outlined, this application requiring not only a small moment of inertia along with high specific torque and overload capacity but also minimum torque pulsation due to tooth harmonics. The motor structure is essentially that of a disk carrying flat permanent-magnet pole pieces in windows and rotating between two wound stator stacks. The design of such a structure and the corresponding torque-speed characteristic involves calculation of five variables: magnetic flux, electric resistance of one stator conductor with half end loop, assuming all conductors to be identical, number of stator conductors (half-turns), w, slight height, and stator core diameter D. The calculations are made with the aid of four functional relations involving these variables as well as the permanent-magnet parameters. The calculations are performed graphoanalytically, by projecting these relations onto the (D,w)-plane. Figures: 4; references: 4 Russian.

2415/9365

STEADYING VELOCITY OF SERVOMECHANISM MEMBER BY USE OF CONTROLLABLE DRIVE

18610110a Moscow MASHINOSTROYENIYE in Russian No 6, Nov-Dec 87 (manuscript received 2 Jan 86, after completion 10 Mar 87) pp 74-80

[Article by V.I. Babitskiy and B.A. Borovkov, Moscow]

[Abstract] The feasibility of steadying the velocity of a servomechanism member in an elastic machine tool by use of a controllable electric drive is established theoretically, computer control applications being of particular interest and its characteristics being compared with those of continuous stabilization. For the purpose of mathematical analysis, the servomechanism member is simulated by a mass with a reduced moment of inertia J_M elastically coupled to a separately excited d.c. motor whose armature has a moment of inertia J_R and field is energized from a controllable voltage source. The automatic control system consists of two tachometer generators, one on the motor shaft and one on the servomechanism shaft, a high-speed voltage regulator and a speed regulator assumed to be linear, also optionally a low-pass filter. Its performance is calculated on the basis of coupled equations of mechanical motion and of electrical transients. The results indicate the main advantage of digital control, namely a larger margin of dynamic stability. Digital controls are also preferred to analog controls for technological and economic reasons. It is furthermore possible to track not only the speed but also the position of the servomechanism rotor by means of an appropriately selected nonlinear regulator. Figures: 5; references: 5 Russian.

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UDC 532.7.08

DETERMINATION OF SHAFT POSITION DURING LIMITED ROTATION

18610213b Moscow IZMERITELNAYA TEKHNIKA in Russian No 10, Oct 87, pp 20-21

[Article by N.F. Markelov]

[Abstract] A method of monitoring the limited reciprocating rotation of one machine element around the stationary axis of another for the purpose of shaft position and perpendicularity or parallelism control is considered, a specific example being the carriage of a machine tool which holds a vertical spindle and rotates with it back and forth through an angle smaller than 90° around a vertical mandrel mounted in an aerostatic, sleeve, or roller bearing. The carriage movement is monitored by means of an indicator on a rack rigidly fastened to the carriage first in the location where it will read zero with the carriage in one position, then in the location where it will read zero with the carriage in another position, then back and forth till it will read again zero with the carriage in the first position. The procedure can be simplified and accelerated by using a ring with several indicators instead of a rack with a single one for a multispindle machine tool. Figures: 2.

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